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WANTED: DIRT FORESTERS

By WARD SHEPARD

Forest Inspector, U. S. Forest Service

Someone said that Carlyle had sounded forth his Philosophy of Silence in 48 octavo volumes. The distinguished editor of the *Journal,* in protesting once more so vigorously against a forestry campaign composed too exclusively of words, might not wholly escape a somewhat analogous implication were it not that his words have so often and so effectively dealt with woods forestry rather than paper forestry. And once again his words touch a vital spot.

It seems to me that foresters have had to take to much writing and talking *because too many of them have been cut off from the actual practice of forestry in the woods.* Being equipped with a profession and with a high ideal of service, it is natural that their energy, so largely deprived of expression *in the forest,* should find an outlet in words. The forestry profession has done a large amount of creative work of the greatest public benefit in the pioneer job of forest legislation and public forest organization. But many foresters have had too little opportunity to practice the science and art of silviculture and management even in its more elementary forms, much less to progress and to perfect themselves in the technique of their profession. This has been a real deprivation. Imagine painters who aren't allowed to paint or gallant sailors doomed to spend their lives in Kansas. Trying to get a tangible hold on the chaotic forest problem, trying to put their shoulders to the wheel, many foresters have been forced back on words as their chief contribution.

What the forestry program needs is *dirt foresters.* I am thinking now of the needs, not of the forestry profession, but of the public. Yet the only way to create a supply of dirt foresters is to create opportunities for the actual practice of large-scale forestry *in the woods.* I mean by forestry not merely silviculture, but the intricate problems of utilization, regulation, and finance—in short, sustained yield management.

The only large training ground now available for turning out foresters equipped to handle large-scale industrial forestry is the National Forests. There is no question that industry will draw on the Forest Service for foresters—it is already doing so. If precedents count for anything, industry will pick the men who have had broad training and practice in forest management. Two men recently drafted from the Forest Service for large scale industrial forestry have had precisely this training in an unusual and thorough degree; for the last decade or more industry has been drawing on the Forest Products Laboratory for skilled forest products engineers. Forest management lags behind utilization; but once it gets started, it will have to go to the National Forests for management experts.

The view has been expressed that big timber companies do not need to employ foresters in order to practice forestry, but should select a good common-sense woodsman and train him for the job. This plan will probably work *so long as there are enough Government extension foresters to supply the brain-power to these companies for good forest management.* As a permanent arrangement it will not work, first, because the Government can't and won't go into the consulting forestry business on an extensive scale; and, second, because as a rule it would be as inadvisable to turn over a large continuous yield enterprise to an untrained woodsman as to turn over a steel plant or an automobile factory to the machine-shop foreman. On the other hand, it is sheer madness to attempt to put these big continuous-yield jobs on green boys just out of forest school. They require forest managers of the best type. In the Forest Service it takes a broad and varied training of from 5 to 10 years to fit one for the job of Forest Supervisor; the Forest Service wouldn't dream of putting a young green forester into such a responsible job.

Here is an opportunity that young foresters ought to heed. If industrial forestry develops anywhere nearly as fast as the signs indicate, there is going to be a fairly brisk demand for foresters *who know*

big-scale forest management. There is a distinct shortage of such foresters, and those who have skill in this field will win the prizes.

The Forest Service of course is primarily interested in administering the National Forests, and it is consciously creating greater opportunities for its men to master the arts of silviculture, management and utilization. This training is going to reflect itself in the higher productivity of the National Forests. But incidentally—and here is the point of main interest for the moment—it is going to create a supply of trained forest managers for industrial forestry. This function may be involuntary, but it will nevertheless be a great contribution to woods forestry.

But the Forest Service ought not to be depended on as the only or even the chief source of trained foresters. The industry itself ought to assume a large part of this job. At present, foresters employed by timber owners have in general fewer opportunities to practice forestry than those in the public service. These privately employed foresters, with some conspicuous exceptions, are primarily engaged in timber-cruising, mapping, logging engineering, or as paid secretaries of organizations.

The industry at present is using more honeyed words than foresters themselves about "industrial forestry." The reality of this movement can be judged as time goes on by the extent to which the *industry takes in and trains "dirt foresters" in the actual technique of large scale industrial forestry, including finance and utilization.* The various forest industrial associations themselves could well afford to pay more attention to dirt forestry and less to desk forestry, propaganda, and whitewashing the very patent fact of large-scale forest devastation.

I therefore respectfully suggest that the many agencies, including industrial associations, that are fighting forestry battles on paper get nearer to the real battle, which is in the woods. Fear is bred of ignorance. Most timber owners fear forestry because they know so little about it. The best antidote to fear is knowledge, and, in forestry, the source of knowledge is in the woods. If, therefore, more of the energy now devoted to the battle of the words can go into the battle of the woods, we shall make faster progress. If the forest-based industries are genuinely interested to find the facts, the way to find them is to help work out ways of modifying logging processes to prevent forest destruction, and of converting going operations to continuous produc-

tion. The medium is through broad-gauged, experienced woods foresters, employed either by individual companies, by groups of companies, or by associations. The very process of studying and thinking about these problems will remove many superstitions current among timber owners and will lead to an interest in forest perpetuation and consequently to a positive, creative attitude toward the forest problem instead of the present indifferent or obstructive attitude.

ON THE SPACE ARRANGEMENT OF TREES AND ROOT COMPETITION

By V. T. Aaltonen
Forest Research Institute, Helsinki, Finland

A determined space arrangement obtains between the trees of a forest. Its inherent nature and manifestations become apparent most easily through a few examples.

A normally dense dry heath Scotch pine stand generally has no seedlings. A few seedlings, of course, may exist here and there, but even they are in a more or less sickly condition. But if a clearing of a few acres or more is cut into the stand, before long seedlings will appear in it which will slowly develop larger and larger. The seedlings will not thrive very close to the mother trees, but require a sufficiently large opening. A definite space arrangement exists between the seed trees and the seedlings.

It is also worth while to study more closely the appearance of the seedlings in such an opening of, say about 20 years of age. It will be peculiar in that respect, that the seedlings in the center of the opening are the highest, and become relatively shorter as we approach the edge of the mother stand. The height of the seedlings, compared to the height of the mother trees, and the distance of the seedlings from the mother

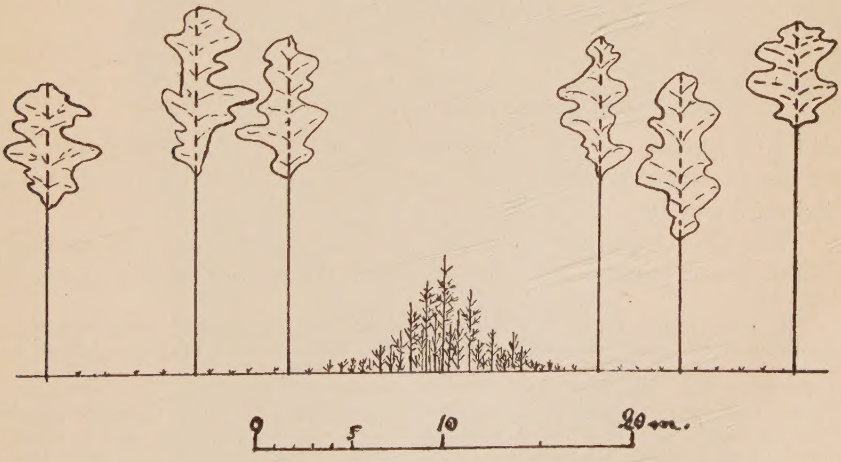

Illustration 1
An Opening in a Dry Heath Pine Stand.

trees are in definite relations to each other. (Illustration 1.) This phenomenon represents one manifestation of space arrangement.

If the question is of a very open stand, an ordinary seed tree spacing for instance, where seedlings have appeared and have been left untouched for a longer period of time, it will be noted that the near proximity of each seed tree does not contain second growth; or, at least, the seedlings growing near the seed trees are much smaller than those growing further. (Illustration 2.) This phenomenon, in fact, is the same as what we observed in the adjustment of the seedlings to the marginal forest in the clearing. The extent to which the seedlings can generally develop in the clearing depends on the density of the seed tree spacing. With the seed trees a profuse seedling stock may exist, but the growth of the seedlings will be weak because of the too dense

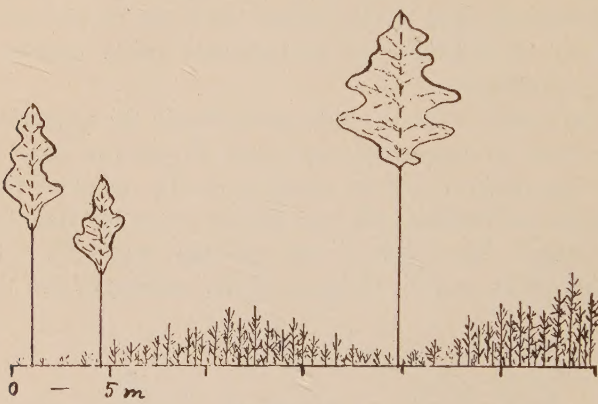

Illustration 2
Single Seed Trees Among Seedlings on a Dry Heath.

seed tree spacing. At first the seedlings succeed well, but insofar as they grow larger the seed trees commence to hinder them. (Illustrations 3 and 12.)

The above mentioned examples have been taken from Cladina and Calluna forest types, hence from stands on the poorest quality of site.[1]

[1]By forest types here are meant *Cajanders'* forest types, user in the quality classification of forest soils in Finland, for the meaning and nature of which I refer to the recent publication: *A. K. Cajander,* Metsätyyppiteoria, Acta Forestalia Fennica, Vol. 29, 1925. The English translation, "The Theory of Forest Types," will appear in the same series, and at present is in print. Compare also: *Yrjö Ilvessalo,* The Forests of Finland, Comm. ex. instit. quest. forest. Finl. editae. Vol. 9, 1924. Cladina type is the poorest producing, the yield then follows in order: Calluna type, Vaccinium (=*Vaccinium vitis idaea*) type, Myrtillus (=*Myrtillus nigra*) type, Oxalis-Myrtillus type, Oxalis-Majanthemum type.

Illustration 3
A felling area where the growth of second-growth has been almost completely stopped by the seed trees. 160 seed trees per hectare. The age of the seed trees is about 100 years; that of the seedlings, about 30 years.

Illustration 12
A spruce underwood in a pine stand.

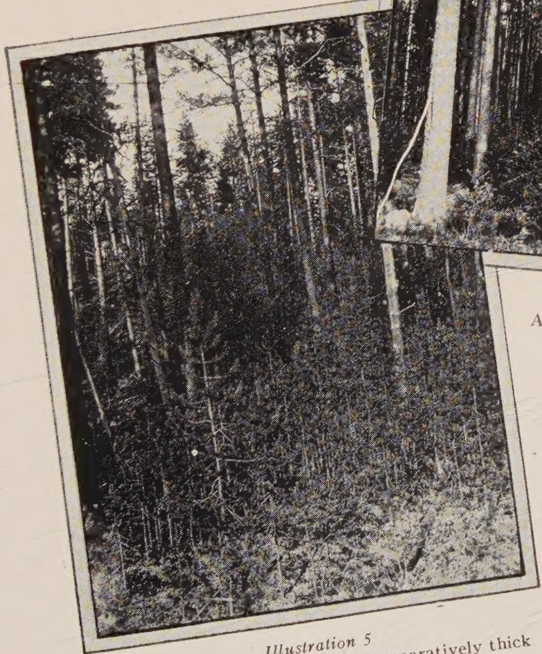

Illustration 5
Good second-growth under a comparatively thick mother forest in the Vaccinium type.

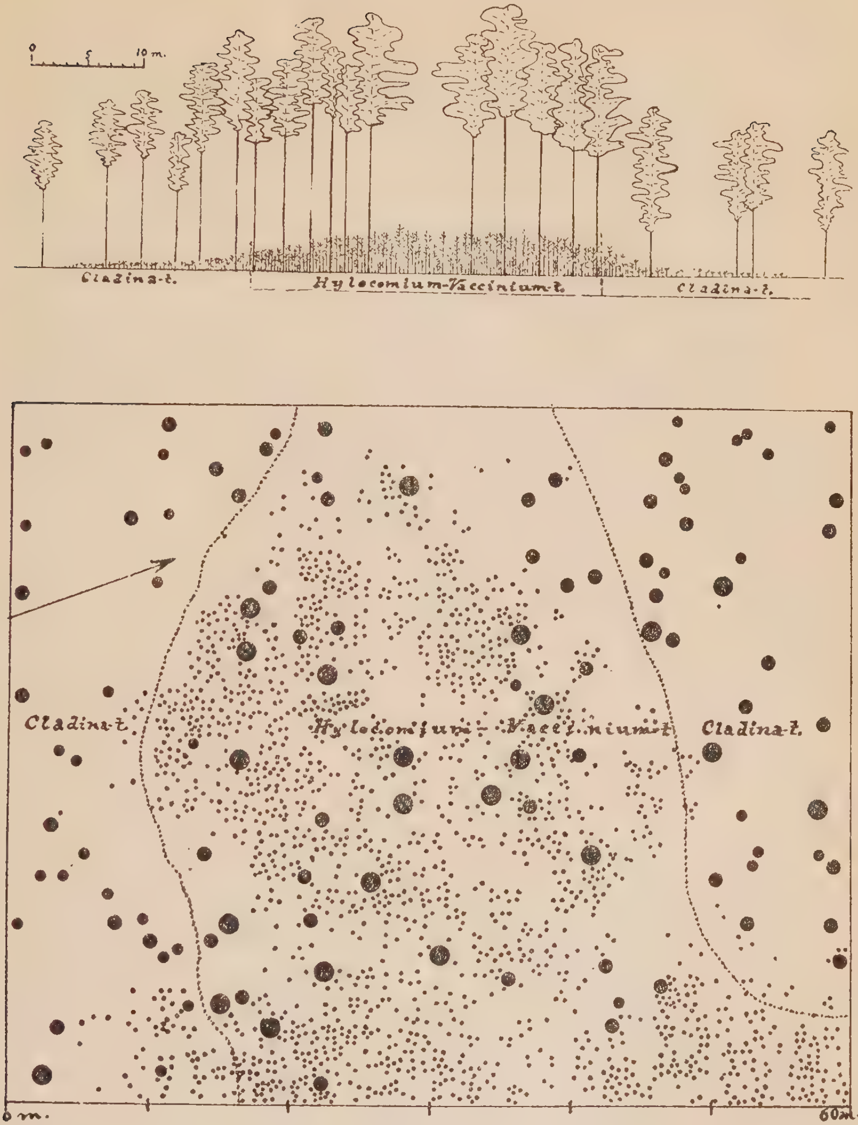

Illustration 4

The effects of forest type on the space arrangement between mother trees and seedlings. The central part Vaccinium type, the edges Cladina type. The diameter-classes of the trunks are: 12-20, 22-30, 32+cm. at breast height; the little dots represent younger age-classes.

The influence of the mother trees on seedling stock in them is very plain.

It is now to be noted that the consistency in the space arrangement of trees becomes so much the more conspicuous as the question is of a poor locality, i. e., of a poor productive forest type.

With reference to the space arrangement of trees, a great difference exists between the stands on Vaccinium type and on those of Cladina type, for instance. In order that the possibilities of development for the second growth shall be the same in both instances the mother forest must be considerably more open in the latter case. The same sized opening in a Vaccinium type as in a Cladina type does not offer the same possibilities of development for the seedlings. In the latter mentioned type the opening must be larger than in the former. If it is a question of an old, single tree growing in a regeneration area, its influence on the seedling stock will extend farther in the Cladina type than in the Vaccinium type. (Illustrations 4 and 5.)[2]

Heath forests, better than those of the Vaccinium type, and grove forests offer an altogether different picture. They differ from the Vaccinium type in the opposite direction to the Cladina type. Seedlings may be found in them most anywhere, not only in small openings, but also even underneath a rather dense mother forest. Sometimes it seems as though there could not be even a question of orderly space arrangement between the seedlings and the seed trees. But the same consistent orderliness nevertheless obtains in these forests as in others. Only, in such cases it is more difficult to perceive.

Up to the present we have considered only the space arrangement existing between seedlings and mother trees. But the same determined order exists also between even-aged trees.

In this instance the space arrangement is expressed by the fact that the trees of the stand are separated by determined distances, i. e., the stand has a definite density. The distance of the trunks from each other, like the arrangement of the seedlings to the mother trees, is closely dependent on the quality of the site. If two stands are compared to each other in which the trees are same sized—where, for instance, the average breast height diameter of the stand is the same—but where one has better site conditions than the other, it will be found that the trunks on the poorer locality are farther apart from each other, i. e., the stand is sparser. Trees require so much the larger growing space

[2] Drawings 1, 2 and 4 are rather formally describing instances of forests in natural condition.

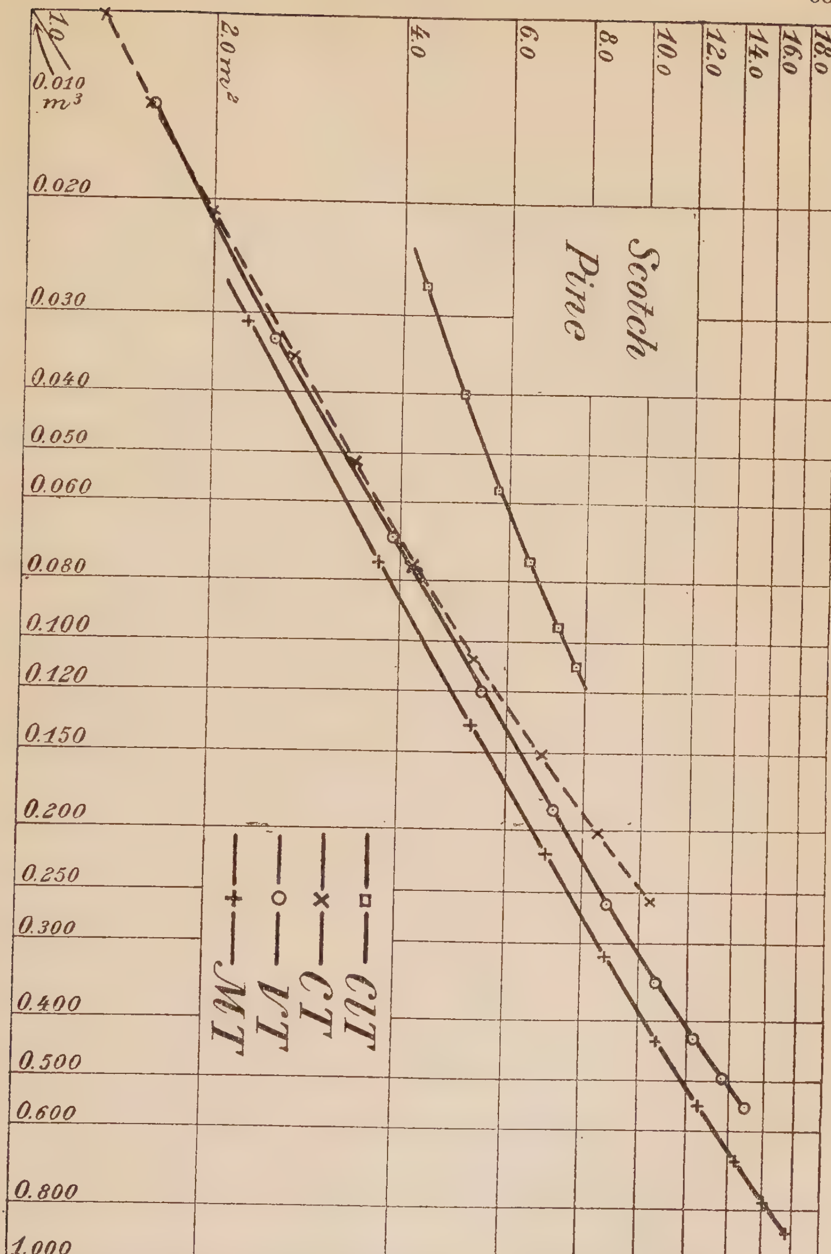

Illustration 6
The growth-area of pine in Cladina type (CIT), Calluna type (CT), Vaccinium type (VT), and Myrtillus type (MT).

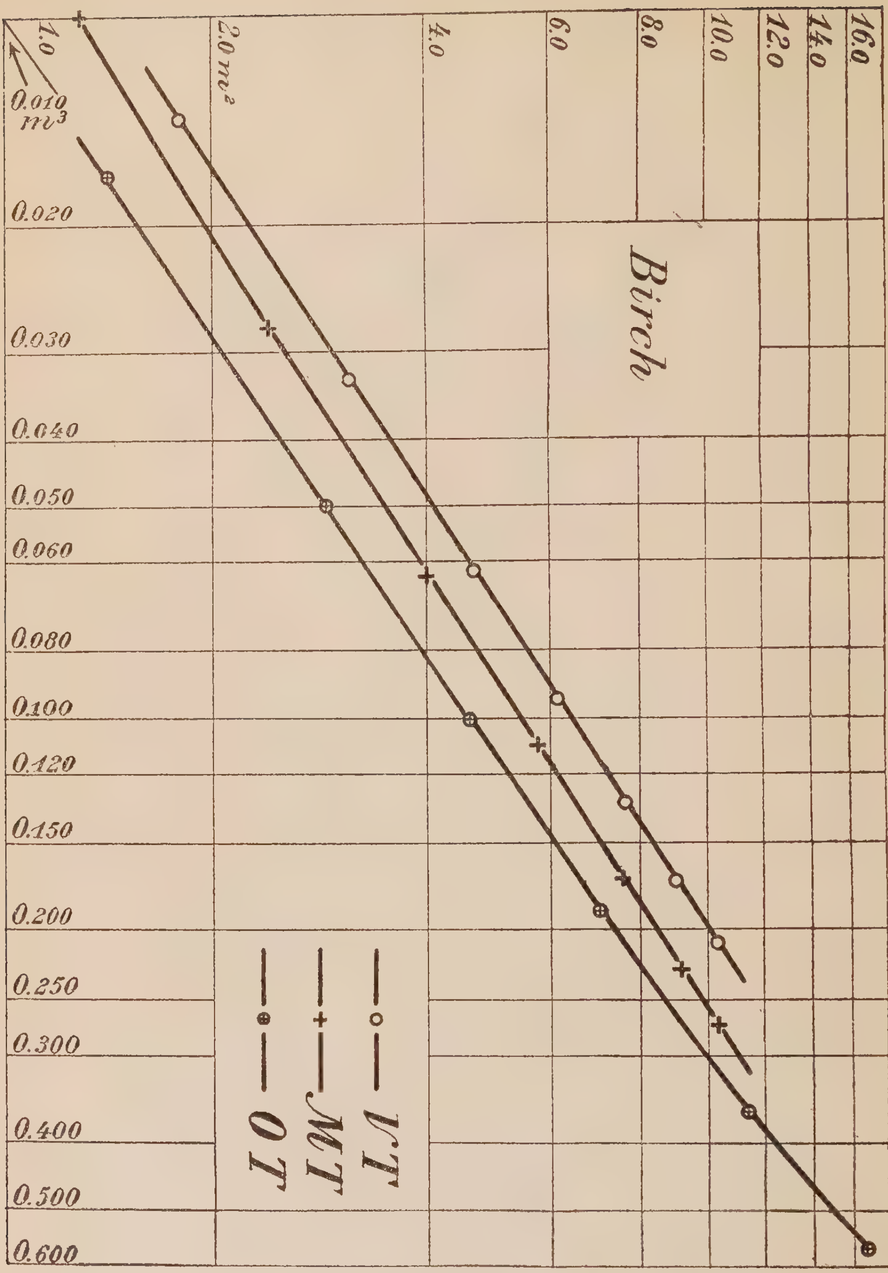

Illustration 7
The growth-area of birch in Vaccinium type (VT), Myrtillus type (MT), and Oxalis-Majanthemum type (OJ).

as the locality is poorer.[3] (Comp. Illustrations 6 and 7; the volumes of the trunks in m^3 are on the horizontal axis, the growth-area in m^2 on the perpendicular axis.)

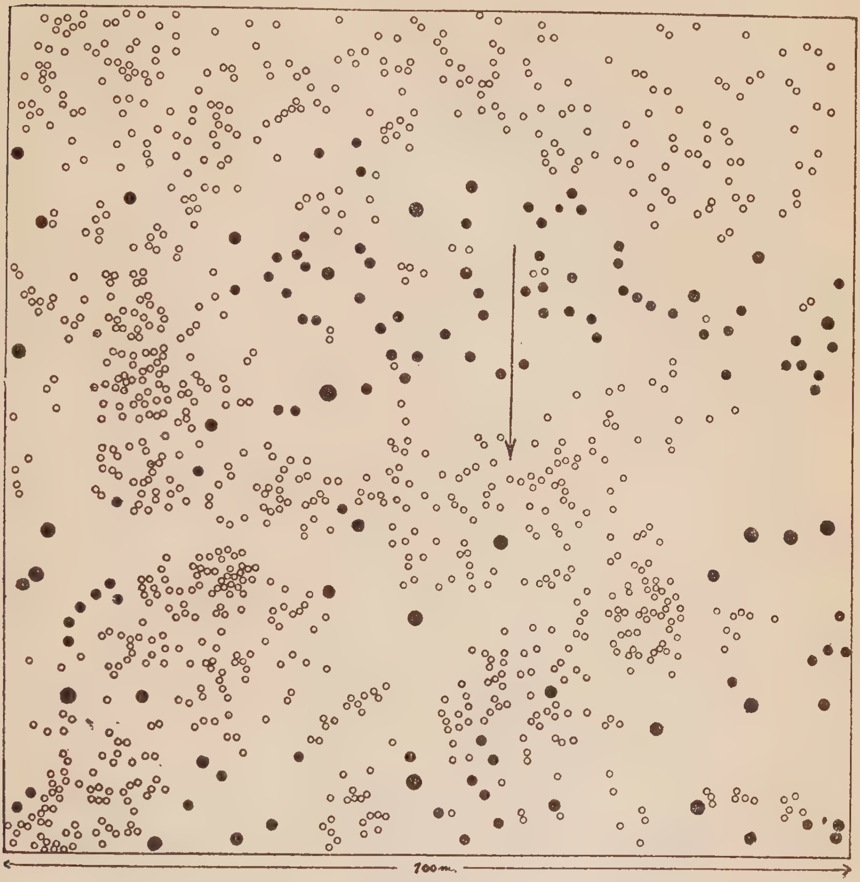

Illustration 8

A map of a Calluna type pine stand. Black dots represent older age-classes; the diameter-classes of the trunks are: 12-20, 22-30, 32+cm. at breast height. The circles represent younger age-classes. (Area, 1 hectare.)

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[3] *V. T. Aaltonen.* Uber die Selbstabscheidung und den Wuchsraum der Bäume in Naturbeständen, Comm, ex. instit. quest. forest. Finl. editae. Vol. 9, 1925.

Diagrams (Ill. 6 and 7), are based on the growth and yield tables for the southern half of Finland, established by *Y. Ilvessalo* based on the forest types as quality classes of localities (published in Acta Forestalia Fennica, Vol. 15, 1920).

But in the forests there naturally is not only the question of the relations between seedlings and mother trees and contrawise, and between trees of the same age, but the age-difference of adjacent trees can sometimes be larger and at other times smaller. Illustration 8 is a map of a Calluna type pine stand where principally two age-classes appear, one 150 years and the other 60 years. Both age-classes are rather well separated from each other in this instance. If we could give a corresponding picture from a stand of better quality of site, it certainly would have a considerably different appearance. In it would not be distinguishable so conspicuously the space arrangement between the trees of the different age-classes; in other words, the relative distance between the trees would not depend so much and so apparently on the differences of their ages.

The space arrangement of trees is not only dependent on the quality of the locality, but also on the species of the trees. In the foregoing we have examined only pine stands. In this connection it is not possible nor even necessary to describe more fully the dependence of space arrangement on the species of trees. It is not possible for the reason that the space arrangement existing between mother trees and seedlings has not been fully investigated in this relation. And it is not necessary for the reason that in this connection the quality of the site has the most important fundamental meaning. It seems certain that what we have described here about the pine, also holds good for other species as well. The diagram for the birch given here (Ill. 7) shows that the birch also requires as much more space as the forest type is poorer. And the following diagram for the beech and the spruce, which is based on the tables of *Flury* of Switzerland, shows the same conditions for these species.

The space arrangement of trees is a very important phenomenon from the silvicultural viewpoint. In fact, silvicultural fellings are nothing else than the re-arranging of the spacing between trees. It is therefore apparent that forests cannot be tended and grown properly unless those influences which decide the space arrangement of the trees are well known.

According to the still prevalent and already an old conception, light is the main factor of growth. Seedlings cannot thrive under the mother forest for the reason that they do not receive sufficient light. Near the edges of the mother forest the second growth is languishing because the mother trees shade them. For the same reason second growth is absent for instance from the close proximity of single mother trees. And the

influence of even-aged trees on each other in a stand also principally depends on the fact that they shade each other, i. e., rob each other of light. The already described dependence of space arrangement on the quality of the locality is explained by saying that the light requirement of trees depends on the quality of the locality; it is so much the greater as the locality is poor and *vice versa.* The stands of meagre lands therefore are open because the trees on them require more light, etc.

A closer investigation of the space arrangement of trees demonstrates however that its only or general reason cannot be light.

It seems that many combined factors decide the appearance of second growth beneath the mother forest. In some cases, however, one factor may be more important than another. A fact to be noted is that an appreciable part of the rain-fall in a stand is left on the tops and branches of the trees without coming down to the soil whatsoever. And the trees consume, i. e., extract considerable quantities of water from the soil. It has been calculated that an old beech forest, for instance, during a period of growth extracts 2-3 million kgs. of

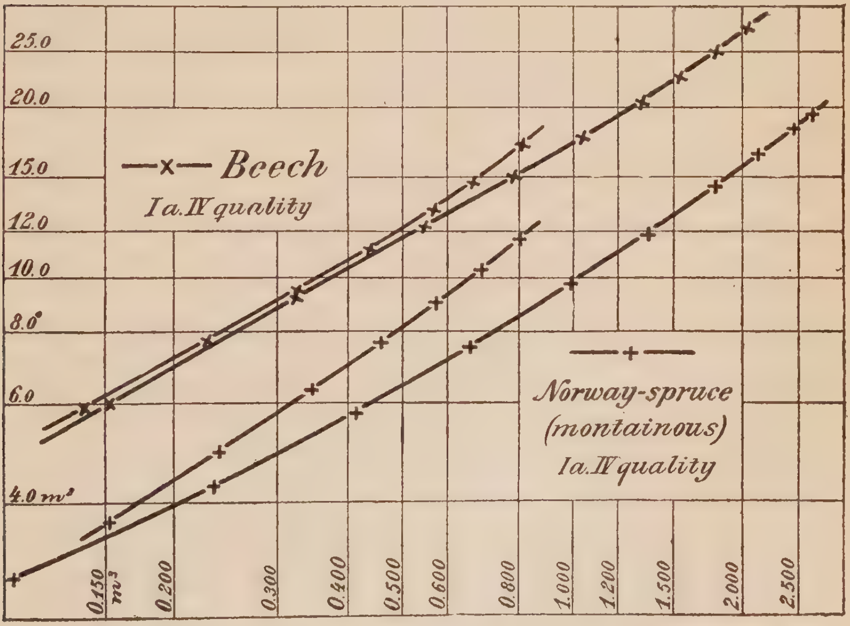

Illustration 9

Lower curve, I quality-class; top curve IV quality-class.

water from each hectare, which is equivalent to a rain-fall of 200-300 mm. If in addition to this it happens that the soil itself is of a dry character, it is very probable that the seedlings will suffer from lack of water. The water consumption and food extraction of the mother trees from the soil undoubtedly is an important reason why the seedlings cannot succeed near the mother trees. Thus we can explain very simply and naturally the difference between the different sites. Let us assume that we have two stands which are alike, but one located in a more moist and an otherwise better locality and the other in a poorer locality. It then will be evident that in the first mentioned instance there remains more water and food supplies in the ground for the seedlings than in the latter mentioned instance. On the other hand, it seems less believable that in common, generally relatively open heath forests there should be so little light that the seedlings of trees could not grow upon them.

The meaning of light seems the less important as we examine a single tree among second growth or study the margin of a stand. (Comp. Ill. 1 and 2.) In both instances the seedlings receive light almost unobstruently; but, nevertheless, they are pygmies compared to those growing further beyond from the mother trees. The space arrangement apparently also in these cases is decided more by the food extraction of the mother trees from the soil than by the shading caused by them.

We already noted that trees require more space on a poor site than on a better one. And as the same space in the former instance represents a smaller amount of food and water than in the latter, it is natural that the growth for equal amounts of space must be larger on the better locality than on the poorer.

The quality of the soil may differ even on a relatively small area; on poor lands there may be here and there a more productive spot and *vice versa*. This does not exist without affecting the space arrangement of trees. The placing of stems geometrically equidistant from each other in planting, etc., does not mean equal possibilities of development for each trunk. The largest trees sometimes grow very close to each other; for instance, 80-100 cm. diametered oaks within one or two meters of each other. The quality of the soil appears to be of more importance than the possibility for the equal development of the crown, as *Bühler*, among others, observes.

We must therefore come to the conclusion that the space arrangement of those parts of trees which are above the soil are mainly decided

by their roots and the competition existing between them for the water and food in the ground.[4]

The same thought has also been expressed by the German foresters. *Cotta, Borggreve,* and *Fricke.* They, however, have concentrated their attention on the root competition existing between the seedlings and the mother trees.[5] According to my conception the same kind of competition exists also between trees of the same age, and generally everywhere where two trees are sufficiently close to each other. From the silvicultural point of view the root competition between even-aged trees seems to have an even more important meaning than that obtaining between mother trees and seedlings.

And further, insofar as root competition has been treated in silvicultural literature, it has been stated to have a meaning only on less productive sites. According to my viewpoint root competition is not limited to any certain site-class any more than the competition for light, for instance, or for any other growth factor.

Even though root competition therefore seems to have an important meaning in the space arrangement of trees and generally with that of all plants, it nevertheless has attracted but little attention from scientists. To my knowledge no systematic studies and experiments have been made for the elucidation of this phase. Personally, I have made two experiments with corn. The arrangement of the experiments and the results, shortly reviewed, were as follows:[6]

The experiments were partly field experiments and partly pot experiments. Illustration 10 will give an idea of the arrangement of the field experiments.

There were two trial plots, marked I and II in the illustration; they were separated by a 50 cm. wide empty strip.

Board frameworks 15 cm. wide, 50 cm. high and 100 cm. long, open at the top and bottom, were sunk into plot I at five different places, 50 cm. from each other, as shown in the illustration. Nine stalks of corn were grown in each frame. In plot II exactly the same procedure was carried out with the exception that the board frames

[4] The author first came to this conclusion in 1916-1917 while investigating the regeneration conditions of pine forests on the dry heaths of Finnish Lapland. The results of this investigation are contained in a publication of the author: Uber die natürliche Verjüngung der Heidewälder im finnischen Lappland. Comm. ex. instit, quest. Finl. editae, Vol. 1, 1919.

[5] It may be also stated that I became acquainted with their thoughts after my own investigations already had led to the ideas stated above.

[6] *V. T. Aaltonen.* Uber die räumliche Ordnung der Pflanzen auf dem Felde und im Walde. Acta Forestalia Fennica, Vol. 26, 1923.

were left out altogether. When the plants were 54 days old and over a meter high, into each intermediate section (1, 2, 3, 4) 36 new plants were sowed. The plants were then allowed to develop without disturbance. When they were harvested the first planted corn was more than two meters high and very luxuriant, spreading its leaves over the intervening sections so that one walked between the rows as in a forest. The younger plants were completely in the shade of the older ones.

When the younger corn was cut its size and dry weight was the following:

FIELD EXPERIMENTS WITH CORN

I

	1	2	(3)	4
Weight, grammes...	17.4	21.7	(8.5)	17.4
Average length, cm..	40	45	(36)	38

II

	1	2	(3)	4
Weight, grammes...	10.1	6.1	(5.2)	7.3
Average length, cm..	27	25	(22)	25

The difference between the plots therefore is appreciable (the noticeably lower values on intermediate bed No. 3 were caused by an accident to the plants). The plants in plot I were considerably better developed. As there was at least no visually detectable difference in the light conditions on the different plots, the difference in growth must have been caused by the fact that the older plants in plot II deprived the younger plants of food and water in the soil. On plot I they could not do it, because their roots were enclosed within a board framework, and for which reason the seedlings grew better.

The pot experiments demonstrated in the same manner how older plants embarrass the food absorption of the adjacent younger ones. The arrangement is explained in Illustration 11.

The experiments were arranged into two main series; in one the humidity of the soil was 35 per cent of weight, in the other 75 per cent. Both main series comprised three sub-series. In one, three plants were grown in the center of the pot; in another, eight plants on the edges; and in the last one, three plants in the center and eight on the edges. Each sub-series contained four pots of the same kind, and the results are their mean values.

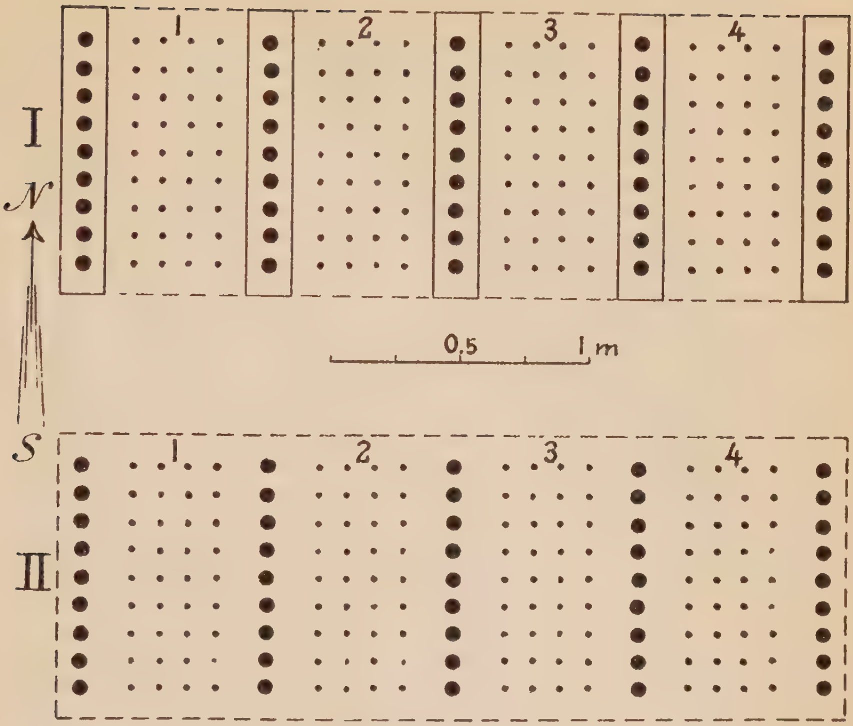

Illustration 10
Field experiments with corn.

At first planting was done only in the center of the pots. When the plants were 60-70 cm. high, into one-half of the pots new plants were planted at eight different places on the edges. At the same time, four pots not containing central plants were planted in like manner at the edges with eight plants. In order that the shading in these cases should also be alike, corn plants that had grown elsewhere and that were the same size as the older stalks, were set up, three in the center of each pot. In pots 4-18, 5-30, 0-29 and 11-28 (See Obs. Illustration) the shading, or the amount of light that the plants received was therefore about equal.

When the plants were harvested their dry weight and mean lengths were the following:

POT EXPERIMENTS WITH CORN

	Center plants	Margin plants	Center plants	Margin plants
Pots No.	1-20	4-18		5-30
Weight, grammes	45.7	26.9	40.3	3.3
Mean length, cm.	75	79	65	26.5
Pots No.	2-26	0-29		11-28
Weight, grammes	57.9	33.7	60.1	4.0
Mean length, cm.	79	76	80	29.3

The center plants therefore had appreciably retarded the development of the plants at the edges through the intermediation of their roots. The production of the marginal plants was only about one-tenth of what it was in the pots where older plants did not consume food, although they shaded as much in those as in the other pots. It also appears as if the smaller plants in the dryer pots had restrainedly influenced the growth of the larger plants; the production decreased from 45.7 to 40.3 grammes.

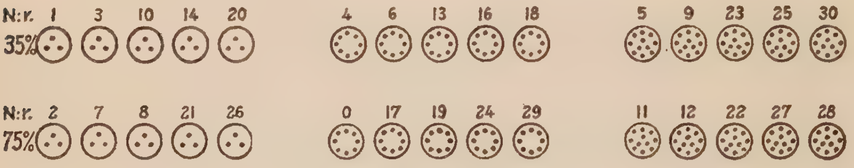

Illustration 11
Pot experiments with corn.

The performance of such experiments with trees meets with many obstacles. Only the long time required by the experiments may be mentioned here. But certain silvicultural procedures are such, however, that they can at the same time be utilized to some extent as experiments in the investigation of the phenomenon in question. One of these processes especially is the growing of so-called underwood.

If—as often has been and is done in Germany—a beech underwood is obtained for a pine stand, according to our theory the underwood generally should have a detrimental influence on the growth of the principal stand. The underwood, of course, uses up a part of the water and food supplies of the soil, and less is left for the share of the principal stand than would be without the underwood. But the idea is prevalent that an underwood promotes the growth of the principal stand, and generally for this reason underwoods have been procured for stands. It is remarkable that no one has taken the trouble to investigate this matter more thoroughly.

Only during recent times has this question come under more thorough study in connection with investigations that are interesting from many other points as well, which Wiedemann[7] has made of the so-called "Dauer" forestry in Germany. These investigations have shown that a beech underwood has not been able in any way to promote the growth of pines, the main trees of a stand. In such instances where the underwood has been well developed, it has completely arrested the so-called "light increment" of the pines at the last intermediate cuttings, so that the increment of pine in such stands has been less than in stands without underwood. In connection with this it can be stated that in investigating the soil no appreciable difference could be found in stands containing beech underwood and those without it.

In our country, and in northern countries generally, a Norway spruce underwood is a common sight in a pine stand. To my knowledge, no investigations of the influence of the underwood on the growth of the main forest has been made in this case, either. Usually, the effects of the principal stand on the underwood is given consideration. I recollect, however, of having heard now and then statements that after removal of the spruce underwood the growth of pine has improved. Hesselman, among others, has wished to explain this phenomenon by saying that it is either a question of competition for water which the pine receives more profusely after the removal of the spruce, or that the food supplies created by the beneficial influence of the spruce have been left for the use of the pine alone.

Another method which can be used as experiment for our purpose is intermediate cutting.

According to our theory the total yield of a stand should be the largest if the intermediate cuttings are heavier at poor localities and lighter at good site-classes. The results of intermediate cutting experiments in Central Europe, in fact, seem to substantiate this viewpoint. At least, according to the yield tables of *Schwappach* a greater total yield is obtained by a heavy intermediate cutting on a poorer and a light cutting on a better quality of site.[8]

The experience in the growth of underwood and intermediate cuttings therefore undeniably points to the fact that the life and activity

[7] Eilhard Wiedemann, Die praktischen Erfolge des Kieferndauerwaldes, Braunschweig 1925.

[8] The author has treated more fully the principles of intermediate cuttings in a discourse on Forest Day at Helsinki, Mar. 24, 1925. The discourse is published in Finnish in the "Metsätaloudellinen Aikakauskirja" (Magazine of Forestry), No. 2, 1925.

of the roots have a fundamental importance in the space arrangement of trees. Lastly, the general experience gained from reproduction cuttings that the regeneration openings may be smaller on good site-classes than on poorer ones also points to the same direction. Continued investigations and experiments for the further elucidation of root competition would in any case seem desirable.

The present conception of the values of different growth factors is not conducive to the tending of forests of different localities in separate ways. It is probable that when more attention shall be devoted in forestry to the silvicultural meaning of different forest types, according to the method of *Cajander,* the conception of light as a growth factor sooner or later will also come under examination.

The meaning of light, of course, is not to be minimized in any way. But as our knowledge in this respect also is at its beginnings, investigations also in this respect would be important. In silviculture, light is given such a predominate weight without considering that hardly any silvicultural light measurements, as yet, have been made in forests. We do not know, for instance, how much light the seedlings of trees require for normal development, nor how large this light requirement is, compared to the amount of light which the seedlings of various trees receive in different localities. These, as well as investigations directly elucidative of root competition are of course not questions of forestry alone, but of plant biology, i. e., plant ecology generally. The botanists here have a field that in addition to offering interesting scientific results of a general nature, also is of great economic importance.

THE WHITE PINE BLISTER RUST IN GERMANY

By Perley Spaulding

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In a series of articles in the German forestry press ranging in date from 1914 to the present time, a controversy has been waged as to the more extended use of the five-needled pines in the forests of Germany, between Harrer and Prof. Tubeuf. This controversy centers around the species *Pinus monticola.*

In his first paper Harrer (2) reviews the qualities of the various species of five-needled pines among other exotic species which have been grown in Germany in small numbers for some years.

Harrer's second paper (3) is not available anywhere in America so far as the writer can find, and for this reason has not been read. Tubeuf's reply (11) gives some inkling of statements made there. Tubeuf especially attacks Harrer's statement that it is not known whether *P. monticola* is susceptible to the blister rust, and says that it was known as early as 1888 that the disease attacks *P. strobus, P. monticola* and *P. lambertiana.* Also that *P. monticola* has been attacked since that time in several places in Germany, and especially seriously in England. Tubeuf goes on to say that the strictest American regulations have been enforced with direct emphasis on this species. That it is a serious reflection on the Administration of Forest Experiment Stations that Practice never or seldom takes note of the results of Investigation. Not a single step has been taken by the German states to combat the blister rust or to prevent its spread. As a consequence, one must advise against further extensions of plantings with *P. strobus, P. monticola* and *P. peuce.* To plant *P. monticola* near *P. strobus,* which is being consumed by blister rust, is like pouring oil on a fire to put it out.

Harrer (4) replies that Tubeuf is really arguing against the further use of any of the five-needled pines. He recites adverse results with *P. strobus,* and concludes by saying that in spite of these this species is planted by millions in Bavaria because of its now recognized good qualities. And that by suitable methods the blister rust can be held in check even as has been done at Grafrath.

Later Harrer (5) published a monograph on *P. monticola.* This gave its native range and habitat characteristics, and enumerated various places in Europe where it has been grown and the results obtained. He

mentions serious attacks of the blister rust, especially at Grafrath, and concludes with the statement that real forestry tests have not yet been made with it in Germany. He apparently does not know of the small block of 100 trees about 25 years old at Stobo, Scotland. In spite of the dangers mentioned he warmly recommends it for further planting in Germany.

Tubeuf (12) in a rather long article considers the whole question in a thoroughgoing manner. Only a few of the main points can be mentioned. He says that the disease has not been controlled at Grafrath as it is still epidemic there. He makes some trenchant remarks on the fundamental difficulty which he thinks is at the bottom of the whole situation, as follows: "Science has, after long years of careful work, completely explained the blister rust. It is for Practice to take the knowledge of the results and apply organized methods. Here I come to the sorest point in Pathology: the cooperation of Science and Administration"—"Plant Pathology is a science and concerns itself with the study of the biology of cultivated plants, their diseases and enemies, with the means and methods of treatment and prevention. It furnishes the principles for practical application to Agriculture, Forestry and Horticulture. Plant Protection compares the available practical methods for preventing and stopping diseases and tests them. Practice has the task of taking the results of experimental knowledge and applying them by means of Plant Protection to practical work. Administration has the task of correlating Science and Practice and taking organized methods of applying the means of therapy and hygiene to general use. There is an essential distinction between Agriculture and Horticulture, on the one side, and Forestry on the other. Administration has, in the first two mentioned departments, to do in the greatest part with individuals. Administration in Forestry has to do in the greatest part with officials who have to manage the state forests and more or less superintend the communal and private forests. The Administration consists partly of judicial and partly of technical officers, who are connected with the council of experiment stations. The results of plant protection are extraordinarily dependent upon the interest of Practice, and the use of organization through Administration. The results of pathological research are extraordinarily dependent, not only on the scientific ability of the investigator, but also on his outlook upon practical management. The means of plant protection must be such that they may coincide with practical management, or become effective through practical management methods. Of the greatest value, too, is the cooperation of the

investigator with the practical man and the practically minded officer of the Administration."

He then outlines a reorganization, or extension of the present organization of the National Board of Health, so as to include plant diseases and pests, and proposes that the present question, "Culture or Abandonment of the Five-Needled Pines in Germany," be taken up as soon as possible and some decision arrived at which will be official for the entire country.

Tubeuf advances certain propositions for the control of the blister rust, as a basis for action by a conference of officials of all branches of the government which are concerned. These cover two sets of conditions: 1st, where there are strong forestry reasons for continuing the use of *P. strobus,* and it is believed that damage from the disease will not be excessive; and 2nd, where extreme measures must be taken.

For the first situation he recommends: I. (1) Growing young *P. strobus* for future plantings from seeds in the forest where they are to be used. (2) Allow *P. strobus* only in such nurseries as are at least "one to two hours' journey" from dwellings and gardens; *Ribes* plants not to be grown in these nurseries nor in their vicinity. (3) Avoid planting *P. strobus* in the vicinity of houses or gardens. (4) Stop further use of *P. strobus, P. monticola, P. peuse* and *P. cembra* as soon as the blister rust appears to be no longer eradicable. (5) Establish a national ordinance forbidding commerce in, and import of, all five-needled pines, and their culture as ornamentals. (6) Inspect for, and remove all blister rusted pine plants. Diseased branches may be cut out, but it is better to be radical, and take the whole tree. (7) Where red, white and black currants are grown near forests, substitute the immune variety Red Holland; cuttings to be propagated in some public garden for the purpose.

For extreme conditions: II. (1) Forbid commerce in, import of and culture of all five-needled pines. (2) Supervise the commercial nurseries. Inspect for, and remove all diseased pine plants. (3) Substitute Red Holland for other varieties of currants in certain locations.

Harrer (6) replies that the kernel of the whole question is, is Tubeuf right in considering the danger from blister rust so great as to justify the prohibition of commerce in, importation of, and further culture of, the five-needled pines in Germany; or, is he (Harrer) correct in holding that the danger from parasites, and especially from blister rust, assumes deadly proportions only when the species in ques-

tion is not handled according to the proper forestry management methods? He cites instances where removal of diseased trees and branches has given satisfactory results. He also says that the cultivation of *Ribes* ought to be restricted rather than that of the five-needled pines. He mentions the 300-yard safety zone adopted here, but errs in implying that it would be efficacious under European conditions. Because of the great frequency of *Ribes nigrum* in the vicinity of European forests where the five-needled pines grow successfully, this distance will surely have to be greatly increased even to prevent commercial damage to the white pine stands. He thinks Tubeuf is too pessimistic. He agrees with his proposition I, 1 to 6, but 7 is scarcely practicable.

Harrer (7) in another paper, which was apparently delayed in publication, gives a statement of the tests of exotics which have been made in Germany, and discusses some of the problems concerned in the introduction of such species into their forests. Here he repeats that he thinks Tubeuf sees too darkly.

Still more recently Tubeuf (13) frankly acknowledges a mistake with reference to *Pinus peuce*. He has found that the supposed stands of this species are actually a mixture of *P. monticola* with *P. peuce,* and that all of the trees which showed the blister rust were really *P. monticola,* while all of the *P. peuce* are healthy. These trees are too small to bear cones, hence the uncertainty as to their identity. He therefore withdraws his objections to this species and endorses Harrer's recommendation of it for further tests. He also feels that *P. excelsa* is promising enough in resistance so that he endorses that species for further test in milder climates. He says that a Commission has been formed to consider the whole question, as was suggested in his earlier paper. (12) He apparently can not quite become reconciled to unqualified approval of extensive cultivation of the white pines, and possibly for the following reason. He calls attention to the fact that numerous hybrids between the different species of pines are known. He fears that such hybrids may lead to increased susceptibility of resistant species through intermixture with susceptible species. Unfortunately the resistant species are scarce in cultivation in Europe. Probably there are trees of *P. strobus* in practically every place that the resistant species are found. This means that they are subject to cross pollination with this susceptible species. His fears may not be unfounded, although actual test only will show just what to expect.

In considering this controversy there are some matters which may be read between the lines, which are of interest to us even at this late

day. Just as here in America, many professional foresters in Europe fail to appreciate what an epidemic disease of timber trees can do when conditions favor the growth and reproduction of the parasite; this in spite of ocular demonstrations to be seen by scarcely going out of their way. Here, the chestnut blight has finally convinced the most skeptical that there really is one fungous disease that is of enough importance to be taken into account. But Europe has not had the spectacle of thousands of acres of an important timber tree killed by an insignificant fungus, to convince her foresters that something which is practically invisible is to be feared. The demonstration furnished by the chestnut blight, of the power of a fungous disease, has done much to educate America. As a direct result we are doing things in America which are not even seriously considered in European countries. The banning, in white pine regions of America, of the cultivated black currant *(Ribes nigrum)* is an accomplished fact and is largely enforced. The removal of all *Ribes* from certain areas where white pines are most abundant and of greatest value, is a regular procedure. The elimination of *Ribes nigrum* in the vicinity of forests of western Europe containing white pines, would, in the writer's opinion, completely and automatically stop the blister rust in those forests. But its removal even from the gardens of foresters living adjacent to the forest is scarcely considered by the officials in authority. There is a curious fatalistic attitude toward the disease. Indeed, Tubeuf (12) says, "The distribution (of blister rust) in Europe has been in no wise controlled, that is, no method of control has been enforced. Today the question is, how to prevent continually increasing the damage." The observations made by Moir (8) and the writer (10) fully confirm this statement, in spite of the fact that a close search was made for places where control had even been attempted.

Another interesting feature of these recommendations of Tubeuf is the fact that there is a variety of cultivated red currant, "Rote Holländische" (Red Holland), which in his opinion is really immune to the disease. Several years ago the writer published the results of extensive cross inoculations (9, p. 17-23) showing that varieties of red currant obtained from nurserymen under the name Holland, Long Bunch Holland, etc., and shortened by the writer to the single word "Holland," were immune or very slightly infected. Hahn (1) has also found this true in later tests. Unfortunately, the stock of a given name from one nursery may not be the same as that of the same name from another nursery. This is true of European nurseries as well as American ones. One must make sure by actual test whether he has the true

resistant variety or not. Other stock received under the names Eyath Nova, Franco-German, Rivers and Simcoe King was also resistant in our tests. It seems likely that some or all of these might be used as substitutes for the more susceptible red, black and white currants in dangerous areas. A trouble in making such a substitution is the certainty that the susceptible ones would to some extent be brought in and planted as being the resistant ones, thus nullifying the effort to control the disease. This difficulty, which apparently can not be effectively overcome, has prevented the serious consideration of such a proceeding here.

Finally, are to be considered the implications of Tubeuf's attitude in this matter. He has had experience for years with the disease in Germany, not only in the laboratory where he has done excellent experimental work with it, but also in the forests, arboretums and ornamental plantings. He has written numerous papers upon the parasite and the disease which it produces. He has apparently presented an unbiased and well matured estimate of the seriousness of the disease to *Pinus strobus,* and so far as opportunity offered, to all of the five-needled pines. He correctly appreciates the danger of such a program of extended planting of these pines in western Europe where the disease is aggressively epidemic, without some means of enforcing control measures.

Tubeuf's limitation of nurseries for *P. strobus* (and presumably all other five-needled pines) to a minimum distance of "one to two hours' journey" from any garden (and by implication the ubiquitous *Ribes nigrum*) plainly expresses his belief in the distribution of sporidia from *Ribes* to pines for a distance of several miles, assuming his journey to be made by the slowest means; i. e., on foot. The evidence in America indicates that the disease may spread naturally for many miles by means of spores from pines blowing to distant *Ribes.* In the reverse direction, from *Ribes* back to pines, we have had no conditions which even approximate conditions in Europe, so that it is not at all surprising that Tubeuf's danger zone to white pines is far wider than we would estimate it. *Ribes nigrum* is not present in any place yet seen in America in such abundance and so generally distributed as it is in most parts of western Europe. This is the reason for the excessive spread and omnipresence of the disease wherever exotic five-needled pines are grown in any numbers there.

Another significant recommendation is the supervision of commercial nurseries. This has been advocated by Tubeuf for years, but the nursery interests were strong enough politically to prevent any

such action. Had this been done when Tubeuf first proposed it we probably would not have got the disease in such wholesale quantities, and might have been able to completely eradicate it finally. It is even possible that the importation of nursery stock would be still going on.

In 1920 Moir studied the blister rust especially in the Scandinavian countries, Great Britain, Belgium and France (8). In 1922 the writer made a study of it especially in Switzerland, Great Britain and France. Both came to the conclusion that *P. strobus* is being exterminated in western Europe. Nothing was known of the situation in Germany from personal examination. Tubeuf's hint that it may be advisable to have a period in Germany, and all of western Europe, if possible, during which no five-needled pines would be grown, so that the disease would die out for lack of sustenance, shows that the situation in Germany is like that in the rest of western Europe. Indeed, it implies that the situation in his opinion is desperate for the susceptible five-needled pines. Such a host-free period for chestnut blight (because we can not prevent it) is considered an opportune time for the establishment of some resistant chestnut to take the place of our vanishing native species. Under the circumstances, such a proceeding is not at all impossible with us. But for Europe, it is the height of folly to allow the blister rust to come to such a pass, when *the mere removal of Ribes nigrum from the gardens within and in proximity to the forests containing the white pines will instantly put it under control in those forests.* If such a thing were undertaken, it might be advisable to eliminate white pines from all but special forests, where they might be concentrated on much more limited areas than at present. The writer saw in the Vosges Mountains and the Alps of Switzerland as finely grown trees of *P. strobus* as he has ever seen anywhere in America. It seems quixotic to throw away such a forestry asset, especially as European foresters now quite generally admit that the timber of *P. strobus* is one of the most valuable that they can produce.

Concerning the different species of white pines under discussion, Tubeuf is right in insisting that *P. monticola* is especially dangerous. Experience here shows that it is very susceptible (10) in native stands. With it should be included *P. flexilis* and *P. albicaulis.* These three species should not be grown in blister rust infected areas unless energetic and effective measures of control are enforced. Extensive cultivation tests ought to be made, as Harrer advocates, but with the most resistant species; i. e., *P. excelsa, P. cembra helvetica* and *P. peuce.*

If these succeed, there is still time to take up the more susceptible species. It seems that Harrer is right in desiring to take advantage of the good qualities of the five-needled pines, *provided* reasonable methods for controlling the disease are put into force and rigidly applied. Tubeuf is absolutely right in his attitude *if* no such methods of control are to be taken. It is to be hoped that the matter will be settled by at least limiting the areas in which white pines may be grown and then applying to those areas the methods of control which experience has shown will be successful.

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METHODS OF PREPARING VOLUME AND YIELD TABLES

Report of the Committee on Standardization of Volume and Yield Tables

The Forest Service has had in mind for several years a series of manual covering methods used in silvical forest research. At a meeting of the Forest Experiment Station men held at the Forest Products Laboratory, Madison, Wis., in March, 1924, the need of such a series was clearly shown, and it was proposed to establish certain definite standards for silvicultural and mensurational research. Because of the growing demand for growth and yield studies, and because no uniform methods were being followed, it was felt that these should receive precedence. To insure that the field would be adequately covered and the forestry profession fully represented, a committee of nine was formed. Three members were appointed from the Forest Service, three from the Society of American Foresters, and three from the Association of State Foresters. The committee immediately began studying different methods in use and proposed, and decided to present those measures which it felt would result in accurate and consistent volume and yield tables. It was not the purpose of the committee so to standardize the preparation of these tables that further research in mensurational fields would be precluded, but to present the best practice now in fairly common use so that any agency preparing volume and yield tables could proceed in confidence that its work would measure up to a high standard of accuracy and completeness. In following these methods, that agency would also have the benefit of previous mistakes and avoid many of the pitfalls that beset the unwary. It is hoped that the committee's labors will result in improved volume and yield tables, and that the outline here presented will be followed by all forest agencies undertaking their preparation.

The members of the committee have devoted considerable time to this task and have cooperated heartily in a work which has developed numerous discussions. In addition to the suggestions offered by the committee members, advice and comment were also obtained from the various Forest Experiment Stations, several of which now have growth studies under way, and from other foresters not formally represented on the committee. Much of the burden of preparing this material has been carried by Donald Bruce rather than by the Chairman.

Recommended Standard Methods of Preparing Volume and Yield Tables

Field Measurements

1. Diameter breast high should be measured 4½ feet above average ground level.

2. The measurements should be taken with calipers, when possible, two diameters at right angles being averaged.

3. The diameter should be measured to the nearest tenth inch.

4. Bark thickness should be recorded at b. h.

5. If the diameter tape be used in place of the calipers a special investigation should be made to determine the average difference between the measurements by the two instruments for the species in question.

6. Total height should be measured from the average ground level to the tip of the leader.

7. Height should be recorded to the nearest one-half foot.

8. If possible, height should be measured by tape or measuring stick before dividing into sections. If not, it should be obtained by summing the lengths of the individual logs plus that of the stump and the tip.

9. Height should be measured with tape or measuring stick.

10. Merchantable height should be taken to a fixed diameter limit; 5 inches if the International Rule is to be used, and either 6 or 8 inches, according to local standards of utilization, if the Scribner Rule is to be used.

11. Age should be determined by stump counts on 10-25 per cent of the trees, selecting those of varied sizes.

12. Diameters up the tree at regular intervals should be measured as follows:

    (a) At 8.15 feet intervals where maximum height of timber does not exceed 5 logs;

    (b) At 16.3 feet intervals for taller timber.

13. The height of stump should be 1 foot in the case of second growth and 1.5 in the case of virgin timber.

14. The following intermediate taper measurements should be taken near the butt of the tree:

    1 foot above stump
    2 feet above stump
    6 feet above stump

8.15 feet above stump
12 feet above stump
(Except in the case of trees which are irregular in form at these points on account of fire scars, turpentining, etc.)

15. Diameters up the tree should be taken at lengths which are measured from the standard stump height (see No. 13) instead of from that actually cut.

16. All diameter meaurements should be taken by means of calipers, and should be the average of two measurements at right angles, to the nearest tenth inch. If diameter tape is used, an investigation should be made of the average difference between measurements by the two instruments.

17. The average bark thickness should be obtained at each point of diameter measurement to the nearest 5/100 of an inch by averaging two measurements diametrically opposite each other.

18. The standard instrument for obtaining bark thickness is the Swedish bark measuring instrument.

19. The following characteristics should be considered as making a tree too abnormal for use in volume tables: forked tops, broken tops, a heavy lean, and turpentining or fire scars which distort the d. b. h. measurement. Tops repeatedly broken back by whipping should not disqualify a tree in species where this is a normal condition.

Office Computation

20. In computing the cubic foot volume the stump should be considered a cylinder, with a basal area equivalent to the diameter at stump height.

21. Logs should be cubed by the Smalian, using short sections as indicated by No. 13 for butt log and 8.15 or 16.3 feet sections, as indicated in 12 (a) and (b), for the remaining logs.

22. The tip should be cubed as a paraboloid.

23. The computations may be performed by multiple basal area tables, by alinement charts, or by the basal area slide rule.

24. In cubing, three significant figures should be retained.

25. The values for the fundamental table should include stump and tip but no bark, while subordinate tables may be prepared for merchantable volume, exclusive of stump or tip, or including bark (see No. 35).

26. In computing volume board measure the standard log rule for second growth is the International ⅛ kerf. In addition, where the

timber is already merchantable the local rule may in some instances be used.

27. For virgin timber, both the International ⅛ kerf and the local rule should be used; preference among the local rules should be given to the Scribner Decimal C Rule, if this has any local acceptance.

28. The tree should be scaled in even 16-foot logs (as in 12) plus a short top section (to the top cutting limit) which is scaled as a fraction of the next longer size.

29. No deductions should be made for defect.

30. No individual tree computations of volume in cords and other units of minor importance should be made since tables based on these are more readily obtained by conversions of the final table (see No. 35).

31. In place of computations of volume, the per cent of d. i. b. at 10 per cent height intervals over d. b. h. may be substituted where taper tables are to be prepared.

Preparation of Tables

32. Separate tables should be prepared for second growth and for virgin timber, the line being drawn at the most probable rotation age.

33. The possibility of separate tables for different sites should be carefully considered.

34. The cubic foot table should be prepared as follows:

(a) The trees should be grouped in the following height and diameter classes:

Diameter, 1-inch classes for species not exceeding 36 inches or 2 inches for species larger than this.

Height, 5-foot classes for species not exceeding 100 feet and 10-foot for species taller than this.

(b) For each height-diameter class the average d. b. h., average height, average volume, volume of cylinder corresponding to these average dimensions, and average form factor should be computed.

(c) These form factors should be curved over height and diameter.

(d) The final table should be prepared by multiplying the curved form factors by the volumes of cylinders computed for the various height-diameter classes.

35. The board measure table should be prepared in the following manner:

(a) The grouping into height-diameter classes should be as follows:

Diameter, 1-inch classes for trees not exceeding 36 inches, and 2-inch for larger timber.

Height, 8-foot classes for trees not exceeding 5 logs in height and 16-foot for taller timber.

(b) For each group the average d. b. h. average height, average volume, and average frustum form factor (based on the frustum corresponding to these average dimensions) should be computed. This computation is facilitated by the use of an alinement chart which permits ready interpolation.

(c) The frustum form factor should be curved over at d. b. h. only.

(d) The final table should be prepared by multiplying the frustum form factor values into values taken from the alinement chart for the various height and diameter classes.

36. Whatever subordinate tables are required, they should be derived from the basic tables by conversion factors based on diameter and height. For example:

Table	*Conversion Factor*
Cords.	Cubic feet per cord.
Merchantable volume to 3 inches.	Per cent of total volume which is merchantable.
Volume outside bark.	Per cent of bark.
Volume board measure based on total height.	Length of top above the merchantable limit.

37. The following checks should be made on all tables:

(a) The aggregate difference between the actual volumes of the trees and those corresponding thereto taken from the tables should be computed. Satisfactory limits of error are ½ per cent for more important tables and 1 per cent for less.

(b) The average deviation of the individual tree volumes from the table should be computed. In this computation the volumes read from the tables should be interpolated to the nearest tenth inch of diameter and foot of height. This may be done readily by putting the table in graphic form.

(c) Where two or more tables have been independently prepared from the same data they should be checked against each other, as, for example, by computing the board foot-cubic foot ratio

or the per cent difference between the volume by the Scribner and the International Rules.

38. The following information should be published with every volume table:

(a) Species, common and scientific name.

(b) Region or locality.

(c) Author and date.

(d) Unit of measure—log rule.

(e) Portion of tree measured.

(f) Basic data—number in each d. b. h. class, number in each height class, location of data by heavy lines.

(g) Method of computation.

(h) Method of measurement (instrument and length of sections).

(i) Average deviation.

(k) Aggregate difference.

(l) Age.

(m) Site, if yield tables exist, if not, physiographic location of material.

39. It is premature to standardize methods of preparing taper tables. The Jonson or Behre formulae are most promising but demand a further study of the factors of bark thickness and root swelling, and the method of field determination of form classes. The conventional methods are of doubtful accuracy.

40. The number of trees required for a satisfactory table depends on two factors:

(a) The average deviation.

(b) The number of entries in the final table. The number of trees collected should be directly proportional with each of these factors, but it is probably premature to set fixed limits. Perhaps 300 or 400 could tentatively be accepted as satisfactory where neither of these factors is abnormally high.

41. In checking the applicability of volume tables a relatively small number of trees may be used. If their aggregate difference and average deviation from the table be calculated, the test for satisfactory accuracy is an average deviation of the same order of magnitude as that for the basic data on which the table was prepared and an aggregate difference which does not exceed two times this average deviation divided by the square root of the number of trees used in the test. In cases of ex-

ceptional importance a check of this sort should be made separately on the smaller and the larger sizes.

Normal Yield Tables for Pure Even-Aged Stands

Field Data

42. The basic data for the preparation of an adequate yield table should consist of from one hundred to three hundred plots for each major type involved, well distributed throughout the range of site classes and ages involved.

43. The plots should be well distributed over the region to be studied so as to include all characteristics of the type's range.

44. All plots should be essentially even-aged, the definition of "even-aged" depending on the reproduction period of the species studied. By "reproduction period" is meant the average time required to secure sufficient young growth on the ground to insure a fully stocked stand at maturity.

45. The size of the plots should be such that they shall include from one hundred to three hundred trees each.

46. The shape of the plots need not be rectangular but there should be at least four sides, and all angles should be greater than 60 degrees.

47. Each plot should be surrounded by an isolation strip of similar timber wherever possible, and where not, as large a proportion as possible of the perimeter of the plot should be thus protected and the boundary on exposed sides should be laid out with exceptional care to include the whole area occupied by the border trees.

48. The survey should be made by staff compass and tape or other means of equal accuracy.

49. Plot areas should be computed on the basis of horizontal distances.

50. Wherever practicable one semi-permanent corner on each plot should be set and tied to some easily identified landmark. A sketch map of the region showing location of plots should also be prepared.

51. All plots should be normal rather than empirical. By strict definition a normal stand is that producing the maximum possible volume in cubic feet for a given age and site (thinnings usually being disregarded); practically, however, this definition must be applied with sufficient flexibility to permit finding plots at a reasonable expense. Obviously, then, the amount of leeway necessary will depend on the character of the species and the region studied.

52. Understocked stands may be identified by such criteria as holes in the crown cover (except for intolerant species), the presence of excessive undergrowth or reproduction, by an abnormally low number of trees per acre, and by abnormally high diameters for the age-class in question.

53. Overdense stands are uncommon, often hard to identify, and should therefore usually be measured whenever encountered unless there is no uncertainty as to their identification. They may have such characteristics as an abnormally high percentage of suppressed trees, very slow diameter and height growth, even on dominants.

54. Stands with pronounced variations in stem density should be avoided where possible.

(a) Age will usually be determined by means of increment borings, approximate average dominants being chosen. Abnormally large trees should be tested to see if they are older than the main stand and occasional small trees bored to ascertain whether the stand is essentially even-aged.

(b) Increment cores should be numbered to permit identification and preserved for later detailed analysis.

55. The length of time required for seedlings to reach the point at which the age was determined must be ascertained by measurements of seedlings on similar sites. Open-grown seedlings should be selected which will obviously develop into average dominants at the ages of greatest importance in the yield study.

56. The d. b. h. of each tree on the plot should be measured with diameter tape or calipers, depending on which instrument was employed in preparing the corresponding volume table; if a different instrument is used average discrepancies between them should be determined.

57. These measurements should be to the nearest inch.

58. All living trees over 0.5 inches, d. b. h., should be tallied.

59. The diameter class limit should be from six-tenths to the following five-tenths, as from 9.6 to 10.5 inches, etc.

60. Measurements should be taken at four and a half feet from the average ground level.

61. All measurements should be tallied by species and by crown classes.

62. The use of three crown classes is sufficient unless perhaps work in the same or adjacent similar regions has been based on four classes.

63. All species, even those of subordinate importance, whether softwood or hardwood, should be recorded, the word "miscellaneous" being avoided. There is, however, no objection to grouping in a miscellaneous column a number of subordinate species, providing that the tally identifies the species of each tree for which record is made.

64. The height and d. b. h. of a sufficient number of sample trees should be measured to permit the drawing of a curve of height over diameter for each plot.

65. The complete range of d. b. h.'s present should be covered by these samples.

66. The number of sample trees required is not a fixed percentage of the total number on the plot but is determined by the number needed to yield a satisfactory height curve.

67. Height should be measured with any standard instrument, such as the Forest Service, or Faustman hypsometer, or Abney, distances being taped.

68. Trees measured should be sufficiently normal to be acceptable for volume table work, forked and broken tops, for example, being avoided.

69. Separate curves are needed for any subordinate species present unless so unimportant proportionately as to make it practicable to use the height curve of the principal species.

70. The height of five to ten mature dominant trees adjacent to the plot should be measured where possible as an aid to site classification.

71. The height of ten to fifteen dominants growing in obviously open or overdense stands adjacent to the plot, on similar sites and of the same age, should be measured wherever found to permit a study of the effect of density on height.

72. The plot description should include the following headings: Crown density; Normality; Per cent of boundary isolated; Type: Distribution; Slope and aspect; Altitude (total and relative); Soil and rock; Soil cover (Underbrush, Advanced reproduction, litter, humus); History (origin, date of fires, date of cuttings, present condition); Tie-survey notes and sketch map.

73. The form of tally sheet may vary with the species and type studied although the U. S. Forest Service Form No. 547 is capable of wide application. It should, however, not omit any of the following items: date; locality; survey notes; name of party chief; plot number; ages of sample trees; average age; area; species; site class (entered in

office); diameter, tallied by crown class; height measurements of sample trees; plot description (see last paragraph). Wherever possible, provision should be made for complete computation on the original sheet of basal area, volume, etc., as filing is much simplified thereby.

74. Since site determination of the plots in the field and by inspection has been found difficult, inaccurate and of little value, but since there is need of some current means of determining whether the plots found are satisfactorily distributed through the various site classes, a tentative series of height-age curves should be prepared on the basis of the first 15 or 20 plots secured, and subsequent plots allocated tentatively to site classes thereby.

75. A two-man party is adequate for the collection of these data. Of these, only one need be experienced. Where more than one party are working in a single study, it is of the greatest importance to coordinate their methods. It is desirable to start with a single party of two experienced men, later to split this party in two by giving each an assistant, and so on. If this is impracticable, at least the man in charge of the project should train each crew when it is starting work, so that he may impress his conception of normality, etc., upon each. It is also essential that one man have direct charge and responsibility of both field and office work.

76. If volume tables are not already available, data should be collected for their preparation. The plan of following and measuring one or two average dominants on each plot has been found inadequate because the range of diameters and heights will not be properly covered. See preceding section on Volume Table Preparation.

Office Work

77. For each plot a curve of height over d. b. h. should be prepared for each important species.

78. For each plot the basal area should be computed to three significant figures and totaled by species and crown class.

79. For each plot the number of trees should be totaled by species and crown class.

80. For each plot the volume should be calculated and totaled by species and crown class. Volume should be interpolated to the nearest foot of height. They may be done with sufficient accuracy by putting the volume table in graphic form or in the form of an alinement chart.

81. The fundamental volume figure is that in cubic feet including the entire wood of the stem. Subordinate figures should be obtained

in board measure by means of the International ⅛-inch log rule. The local rule should also be used in cases where the material involved is now merchantable, preference being given to the Scribner if it has local acceptance.

82. For each plot the average d. b. h. is calculated by dividing the sum of the basal areas by the number of trees.

83. For each plot the average height is read from the height-diameter curve corresponding to this average d. b. h.

84. For each plot the actual total age is determined by adding the seedling allowance to the average of the determined ages.

85. For determining the site index a series of curves showing the relation between the average height of the dominant trees and ages should be prepared. The basis should be the average height of dominants (or of dominants and co-dominants) at 50 or 100 years, depending on the probable rotation age. The curves should be at ten-foot intervals at the selected age. The height of individual trees, if used at all, should be merely a guide to the location of the curves. The curves should, of course, be applicable to the principal species being studied.

86. The site index of each plot should be read to the nearest foot. By site index is meant the average height of dominants which the plot has attained or will attain at the age chosen for classification.

87. In cases where the ultimate height is used for site classification purposes, these ultimate height values should be correlated with the height at the classification age, and the site index number obtained thereby. In other cases this should be done wherever practicable, as an aid to application of the tables.

88. A summary should be prepared for each plot for all species showing the basal area, number of trees, volumes in cubic feet and board feet. The foregoing should be for all trees on the plot. The same information should be summarized for the dominants and in addition, the average basal area per tree and the average height corresponding thereto.

89. Compute the number of trees, the average basal area and the corresponding average height for the trees above a diameter limit fixed by the board foot volume table which is to be used.

90. Compute the plot area and express all summarized figures on a per acre basis.

91. The rejection of plots should be based primarily on deviations in basal area from the tentative curves of basal area over age and site.

92. For this purpose preliminary curves should be prepared of basal area on age by site index classes, and the deviation of each plot from these curves computed, interpolating to the nearest year of age and nearest foot of site index. The standard deviation should then be computed (using the approximation formula 1.25AD = SD) and all plots deviating by more than two standard deviations should be rejected.

93. The remaining plots should be sorted by age and site index classes. The classes should be 5, 10, or 20 years in age, depending on the range of ages, and 5, 10, 15, or 20 feet of site index, depending upon the range of site indices.

94. For each class the following totals should be computed: number of trees per acre, and volume per acre in board feet and in cubic feet. The average basal area per tree should then be obtained by dividing the total basal area per acre by the total number of trees per acre. The average height should be obtained by giving each plot equal weight. The foregoing figures should be obtained for the entire stand, for the dominant stand, and for that above the diameter limit fixed by the board foot volume table used.

95. In preparing these figures the plots should be given equal weight by using the per acre figures.

96. Harmonized curves should be prepared by site index classes over age for each element mentioned in paragraph 94. Many of these curves may profitably be developed by means of anamorphosis.

97. Curves of average basal area per tree should be substituted for those of average d. b. h., the final results being translated into terms of diameter for entry in the tables.

98. The following checks should be used: 1. The number of trees per acre times the average basal area per acre should equal the total basal area per acre. 2. The number of trees per acre times the volume from the volume table corresponding to the average diameter and height should equal the average volume per acre. Both these checks should be applied to the entire stand and to the dominant stand. Check No. 2 should be applied both to the board foot and cubic foot curves. In addition, the board foot-cubic foot ratio when plotted over d. b. h. should produce a single curve of normal shape for all site index classes. Furthermore, the percentage ratio between the total stand and dominant stand values for all factors when plotted over the average d. b. h. of the entire stand should produce a well defined curve of reasonable shape.

Lastly, for all factors, the aggregate difference between the actual measurements and those indicated by the curves, should not exceed 1 per cent.

99. Average deviations of the individual plots from the curves should be computed for the following factors: basal area per acre, number of trees per acre, volume board measure per acre, and volume in cubic feet per acre.

100. The frequency distribution of the diameter classes should be investigated and if the "normal" distribution is found, the standard deviation should be curved over average d. b. h. This will permit the preparation of stand tables for any age and site.

101. Even if this frequency distribution is not normal, the existence of any characteristic type will permit the preparation of subordinate tables (such as trees above 4 inches d. b. h., etc.), by curving the ratios between the factors for the stand above such a limit to those for the entire stand over the average d. b. h.

102. Subordinate tables such as those in cords, those for trees above 4 inches in diameter, those for volumes below a three-inch top, etc., should be deduced from the primary tables by converting factors instead of by direct preparation.

103. The following information should be included in the tables:

(a) Species, common and scientific name.
(b) Forest type.
(c) Region.
(d) Author and date.
(e) Basic data—number of plots used and their distribution through the site and age classes.
(f) Definition of site index used.
(g) Collectors of field data.
(h) Average deviations of individual plots from the yield table values for factors mentioned in No. 98.

104. All tables should contain information on the following factors:

(a) Average total height of dominants.
(b) For entire stand: the
  (1) D. b. h.
  (2) Total height.
  (3) Number of trees per acre.
  (4) Basal area per acre.

(5) Yield in cubic feet, entire stem, without bark.

(6) Yield in board feet, International (⅛-inch) log rule.

In addition, tables giving similar information for the dominant stand, for the stand above one or more diameter limits, for yields in other units, or to other limits of merchantability, should be included as needed.

Committee Members

Forest Service	*Society of American Foresters*	*Association of State Foresters*
Edward C. Behre	H. H. Chapman	J. S. Illick
Donald Bruce	T. S. Hansen	M. B. Pratt
Edward N. Munns (Chairman)	D. T. Mason	E. O. Siecke

THE MISSION OF FOREST RESEARCH*

By Samuel T. Dana
Director, Northeastern Forest Experiment Station

"Forest research"—what mental picture do these words bring to your mind? Do you see a group of impractical theorists, absorbed in their own studies, out of touch with the world of affairs? Does their work seem to you harmless, perhaps interesting, possibly useful in a vague, remote kind of way, but by no means vital to the successful practice of forestry?

The fact is that forest research is neither dull nor useless. On the contrary, there is no phase of the forestry movement that is more full of interest or more essential to its progress. We talk glibly of establishing national and state forest policies, of putting a stop to forest fires, of reforming the present system of taxation, of "reforestation," and sometimes even of practicing silviculture. Do we realize that the achievement of any one of these highly desirable objects involves the solution of a large number of exceptionally difficult problems? Still more, do we realize that today problems are really solved only by thorough-going investigations by trained men?

This has not always been the case. In the Middle Ages such metaphysical questions as how many angels could stand on the point of a needle, and such practical questions as whether a large stone falls faster than a small one, were settled by philosophic discussions. He who could present the most specious reasoning and the most persuasive arguments won the day. Galileo suggested that discussion be supplemented, if not replaced, by actual trial. His famous experiment to determine whether a large or a small stone fell faster from the leaning Tower of Pisa did more than put a stop to further academic argument of that question; it ushered in the modern method of scientific research.

I sometimes wonder whether in forestry we are not still living in the Middle Ages. Argument and discussion have their place, but would they not accomplish more if they were based on facts rather than on mere opinions? Instead of contenting ourselves with forensic debates as to whether lopped hardwood slash decays more rapidly than unlopped, whether two-year-old seedlings or four-year-old white pine transplants are preferable for the planting of abandoned pastures,

*Delivered at Second New England Forestry Congress, Springfield, Mass., Dec. 11, 1925.

whether spruce should be logged by the clearcutting or the selection system, why not do some investigating and find out? This is the task of forest research.

Those engaged in it may be likened to the detectives in a murder mystery, and to the host of alienists, bacteriologists, microscopists, finger-print experts, and other specialists whom they call to their assistance. We hear much of the forest tragedy which is being enacted, but all too little of the most effective way to find out how to stop it. What policies and methods should be adopted to convert forest destruction into forest production is a real mystery which involves not one riddle but a thousand. Forest investigators are the detectives whom we should call upon to solve them. The clues are many and varied, but they are also so tangled and frequently so slight that their unraveling will require years of intensive study by skilled experts in many fields. Let me illustrate by a brief review of some of the work now under way and in prospect at the Northeastern Forest Experiment Station.

The chief puzzle which has so far engaged the bulk of our attention is how to handle the extensive forests of spruce and balsam fir in the northern part of the region. Our first step toward its solution was to start a comprehensive study of areas which have been cut over at different times and in different ways to determine just what the results have been. For this purpose some 400 temporary sample plots have been examined from eastern Maine to western New York. On each a careful record has been made of the number and rate of growth both of the trees left at the time of the cutting and of the reproduction which has come in since, together with detailed notes concerning other vegetation and such physical factors as slope, exposure, and soil, which might influence the results. A series of permanent sample plots has also been established on the White Mountain National Forest, where still more intensive observations and records have been made which will be repeated at regular intervals.

The figures have not yet been completely analyzed, but a preliminary study of them indicates a number of clues. For one thing, it is clear that nearly all of the spruce and balsam fir seedlings now on the ground had started before the main stand was cut, and that their number and development vary directly with the amount of hardwood, particularly beech and hard maple, present. This means that if one desires to secure a new crop of spruce and fir he must see to it that ample seedlings of these species are present before the removal of the original stand, and that as few hardwoods as possible are left.

But what favors the establishment of natural reproduction? The answer to this is not easy, particularly as superficial evidence is more or less contradictory. In one case light, in another soil moisture, in another soil nutrients, and in still another seedbed conditions seems to be the determining factor. This doubtless means that all of them are important, and that successful reproduction is dependent on their proper combination, which must be brought about by the way the stand is handled. Here, then, is a tangle of clues, the unwinding of which will require the joint effort of foresters, physiologists, physicists, chemists, and soil scientists. Difficult? Yes, but all the more fascinating for that. Is there any adventure more interesting or more worth while than to penetrate the unknown, particularly when this involves so useful a service as increasing the future supply of raw material for our newspapers and magazines?

In the field of fire control we have also been doing a little detective work. Here, one of the mysteries is what constitutes "fire weather." During the past summer we have attempted to find an answer by instrumental measurements taken five times a day of six different meteorological factors and of the corresponding moisture content of the duff, or partially decomposed leaves. These indicate relative humidity of the air and number of hours since last precipitation as two of the major clues to the solution of this particular riddle. In the mixed spruce hardwoods type of the western Adirondacks, where the study was conducted, a rainfall of one-tenth inch or more ordinarily saturates the surface duff sufficiently to obviate any danger from fire for about 36 hours in the open and for 24 to 48 hours longer under a hardwood cover. After the influence of the rainfall has disappeared changes in the moisture content of the surface duff follow very closely changes in the relative humidity of the air, and a period of fire hazard usually exists for several hours each day.

Much still remains to be learned concerning the influence of different meteorological factors on moisture conditions in other forest types and with other forest fuels, and concerning the moisture content at which there is danger of fire being started by matches, cigarette stubs, pipe heels, cigar butts, camp fires, and burning brush piles. Already, however, the study has progressed far enough to serve as a guide as to when brush burning is safe, when lookout watchman should report for duty, and when extra patrols should be put on and other special precautions taken. Eventually, it is reasonable to expect that it will prove feasible to determine just what the inflammability of different

types of forest and cut-over land will be under any given set of weather conditions.

These specific illustrations of what forest research means are taken from the Northeastern Forest Experiment Station merely because I happen to be most familiar with its activities. Forest schools, state forestry departments, agricultural experiment stations, even corporations and individuals, are pushing back the frontiers of ignorance in other fields. More problems are being studied by more agencies in the Northeast than in any other section of the country; yet their combined efforts are far from adequate. We must employ more detectives, more forest investigators, if we wish real enlightenment on the management of our forests.

Forest research has so far failed to receive the attention it merits for two chief reasons—first, because we have overestimated our original timber supply; second, because we have underestimated the difficulty of replacing it. Cold figures have never really convinced us of the rapid disappearance of our virgin forests and of the inadequacy of the stands by which they are being replaced. On the other hand, we have listened with willing credulity to promises that all would be well if we would only keep out fire, or enact just tax laws, or expand the public forests. Unfortunately, forestry—real forestry—is not so easy as all that. These measures, admirable as they all are, merely give nature and the forest owner a fair chance. They do not create knowledge as to how best to handle our widely varied and badly run down forests, nor do they insure its application.

We have dilly-dallied along until we have created a gap between timber consumption and timber production which it will take herculean efforts to bridge. Giving nature a chance will help, but by itself is not enough. We have got ourselves into a fix where we can henceforth meet our own needs only by improving on nature in forestry as we have in agriculture. This will require skill of the highest order. Nothing short of the most intensive possible forest management will produce the fully stocked, rapidly growing stands of desirable species which alone will make us self-supporting in our timber requirements. It is no exaggeration to say that how to produce stands of this character still remains for the most part a profound mystery. The detective simile is not far-fetched.

So far, we have largely spent our time tinkering with symptoms and searching for panaceas. It is time to get down to fundamentals.

This means research in forest production, research in forest utilization, research in forest economics. It means research not only of the more or less empirical, rule-of-thumb character with which we have for the most part so far been content, but basic research of the sort that seeks for causes as well as for facts. This will take time. Like Rome, forests are not built in a day. Do you realize how greatly this fact complicates research with trees as compared with an annual crop like wheat? It was twenty years before we realized that the rapid growing Scotch pine which we had planted in this state with such apparent success was beginning to twist like a cork-screw. It was a hundred years before the Germans learned that the pure stands of Norway spruce, handled by clear cutting and planting, which they had regarded as their most conspicuous example of financially profitable forestry, were really depleting the soil and were silviculturally a failure.

Forest research of the right kind is not spectacular and can not be hurried. Conclusions too hastily arrived at should be viewed with as much suspicion as a security that yields too high a return. This element of time means that reliable results can not be made available before the demand for them becomes acute, and emphasizes strongly the inadequacy of our present forest research program. Agricultural experiment stations are now supported by appropriations of more than $10,000,000 a year, forest experiment stations by less than $200,000. Yet the forest problems of the country are no less difficult than the agricultural problems, and the time required for their solution much greater. An immediate and substantial enlargement of our forest research activities by governmental, institutional, and private agencies is one of the outstanding needs of the forestry situation today, and would prove one of the most profitable investments we could make.

I make this assertion with full knowledge that research is looked at askance by many as being "theoretical." The so-called "practical man" who makes this criticism fails to realize that a theory is nothing but an attempted explanation of the facts, and that his own practice, so far as it has any basis at all, rests wholly upon theory. It is, therefore, important, particularly in forestry where action on a mistaken theory may be impossible of correction for fifty or a hundred years, to make as sure as is humanly possible that our theories are right. No more practical way of doing this, in forestry or any other field, has yet been discovered than by the impartial collection and analysis of all available facts, in other words by scientific study.

The mission of forest research is to replace ignorance by knowledge, and in so doing to enable us to develop forest policies and methods of forest management not by the medieval method of philosophical discussion but on the sound basis of established facts and principles. The progress of the forestry movement depends in large measure on the extent to which research receives adequate moral and financial support.

A FOREST TYPE CLASSIFICATION FOR THE SOUTHERN APPALACHIAN MOUNTAINS AND THE ADJACENT PLATEAU AND COASTAL PLAIN REGIONS

By a Committee of the Southern Appalachian Section
Society of American Foresters

The territory for which the accompanying type classification was prepared includes the Southern Appalachian mountain and highland region south of Pennsylvania, and those parts of the Piedmont Plateau and the Coastal Plain lying in the states of Maryland, Virginia, and North Carolina. Two forest type classifications have previously been made. One of these, used by the Forest Service in the acquisition of National Forest lands in the mountain region, is based upon merchantable lengths of timber and recognizes only "cove," "lower slope," "upper slope," and "ridge" types. The other, proposed by W. W. Ashe,[1] recognizes 35 types named for the characteristic tree species of each. The first was regarded by the Committee as inadequate for satisfactory forest description for purposes of management or investigation. The second, while of high ecological value, contained too fine distinctions for ordinary use in forestry.[2] The task of the Committee was therefore to formulate a logical series of types simple enough for easy field use but differentiating all the outstanding, extensive, and important groupings of species.

The question of what is a forest type has never been definitely settled. The meaning of the term is influenced by commercial, ecological, and forest management considerations. Most of the classifications in the United States are based upon forest composition, "cover type," named for either the predominating species or for one or more "key"

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[1] "Forest Types of the Appalachians and White Mountains," by W. W. Ashe. Journal of the Elisha Mitchell Society, Vol. 37, March, 1922.

[2] Two rather broad classifications of Southern Appalachian forests have since appeared as parts of general classifications for the whole United States. Livingston and Shreve (in Publication No. 284 of the Carnegie Institution of Washington, "The Distribution of Vegetation in the United States, as Related to Climatic Conditions," 1921) recognize five vegetational groups in the region: northern mesophytic evergreen forest, northeastern evergreen-deciduous transition forest, deciduous forest, southeastern evergreen-deciduous transition forest, and southeastern mesophytic evergreen forest. Shantz and Zon (in Atlas of American Agriculture, Part I, Section E, "The Natural Vegetation of the United States," 1924) recognize six groups: spruce-fir, birch-beech-maple-hemlock, chestnut-chestnut oak-yellow poplar, oak-pine, longleaf-loblolly-slash pines, and cypress-tupelo red gum. While broadly descriptive, neither of these classifications is sufficiently detailed for practical use in forest operations.

species. The Committee adopted the cover type principle, and named the types after one or two predominating species wherever it was practicable to do so.

The Committee's chief difficulty was in reconciling and combining the many suggestions received in answer to inquiries, to conform to its objective. While the Committee realized that no classification could be devised at the outset that would satisfy all purposes equally, it recognized the importance of an at least provisional agreement among foresters upon one standard set of type names and definitions to make forest descriptions generally intelligible throughout the profession. The Committee's report, embodying the list of types which follow, was adopted in substance at the meeting of the Southern Appalachian Section of the Society at Asheville, February 12, 1925. At the same meeting a slightly different committee was appointed to receive and consider suggestions for amendment which might be offered.

The Committee has attempted to make the classification as inclusive as possible without enlarging the number of types to a point at which it would cease to be of practical utility. Some of the types, like spruce-fir, are much more clear-cut than others, and there are transitions, some of which are noted, which can not well be given type names because they partake of the character of more than one of the named types. It is believed, however, that all the more important forest types of the region are described in the list, and that the amount of transition forest is relatively insignificant.

Committee on Forest Type Classification,

E. H. Frothingham, *Chairman,*
J. S. Holmes,
W. J. Damtoft,
E. F. McCarthy,
C. F. Korstian.

Forest Types of the Mountain Region

Northern forest, mostly at high altitudes

1. Spruce-fir
2. Hemlock-yellow birch
3. Northern hardwood

Moist slope and cove forest

4. Buckeye-basswood

5. Northern red oak
6. Cove hardwood
7. Yellow poplar
8. Cove hemlock
9. White pine
10. Chestnut
11. White oak

Dry slope and ridge forest

12. Chestnut oak
13. Black oak-scarlet oak
14. Pitch pine-mountain pine

Forest Types of the Plateau Region

15. Plateau oak
16. Post oak
17. Shortleaf pine
18. Virginia pine
19. Red cedar
20. River-edge hardwood

Forest Types of the Coastal Plain Region

21. Loblolly pine
22. Longleaf pine
23. Bottomland hardwood
24. Swamp hardwood
25. Southern white cedar
26. Pond pine
27. Live oak

Mountain Types

1. Spruce-fir type

Red spruce and southern balsam fir pure or predominating, associated, in the lower altitudinal portions of the type, with hemlock and northern hardwoods, especially yellow birch. Beech, sugar maple, buckeye, cucumber, and hawthorn are frequent associates at the lower altitudes, and the type grades over into the northern hardwood type, or occasionally, on south exposures, into some of the moist or dry slope hardwood types. Variants of the type include pure fir, pure spruce, and spruce-yellow birch stands. The fir is characteristic of the highest altitudes, often forming nearly pure stands, but is also found lower down, usually mixed with spruce and in smaller quantities. Pure

stands of spruce are much more common and extensive than pure stands of fir. The spruce-yellow birch stands contain yellow birch and other northern hardwoods and hemlock, and gradually merge into the northern hardwood or the hemlock-yellow birch type. Fir is an occasional associate in the southern mountains.

Found at elevations of over 4,500 feet in the Southern Appalachian mountains and over 3,250 feet in the Alleghany highlands of West Virginia, on all exposures.

Replaced, after clear cutting and fire, by blackberry, raspberry, rhododendron, elder, fire cherry, yellow birch and other northern hardwoods, tending toward ultimate seizure by yellow birch forest except at the highest altitudes. Spruce and fir usually reproduce very little if at all after fire, and only sparsely after cuttings heavy enough to allow duff to dry out.

2. *Hemlock-yellow birch type*

Hemlock *(Tsuga canadensis)* nearly pure or predominant, commonly associated with yellow birch. Other common associates are buckeye, sugar maple, and beech.

Generally on high cool slopes of northerly exposure, at elevations below 3,500 feet in the northern and 5,000 feet in the southern part of the region. This high altitude type is above the altitudinal range of the species which, as associates with hemlock, characterize the cove hemlock type.

Usually replaced, after logging, by yellow birch. Hemlock represented only by advance growth.

3. *Northern hardwood type*

Yellow birch, beech, and sugar maple, mixed or in pure stands, associated with hemlock, red spruce, southern balsam fir, buckeye, basswood, black birch, cucumber, white ash, black cherry, northern red oak, and chestnut, some of which are occasionally found in small nearly pure groups. Variants of this type are yellow birch, sugar maple, and beech stands.

At elevations of from 3,500 to 5,500 feet in the southern mountains, lower in the mountains of northwestern Virginia, West Virginia, and Maryland, where it enters the coves. This type occurs generally below the spruce and above the southern upland forest on northerly exposures, or rarely on very high southerly slopes. But sugar maple reaches lower elevations in places in the mountain region, especially on the Alleghany and Cumberland Plateaus, where it sometimes predom-

inates on the stream bottomlands and moist slopes. Pure stands of beech occupy small areas along the crests of the ridges, mountain summits, and high benches, between 4,500 and 5,000 feet elevation (in North Carolina). Beech also predominates occasionally on river flats and moist lower slopes in the Alleghany and Cumberland region as low as 800 or 1,000 feet altitude.

4. *Buckeye-basswood type*

This type may be considered a transition between the northern and the southern upland forests. Mixed forest, in which buckeye is usually characteristic, often predominant or pure, with basswood a common associate. Other associates are yellow and black birches, beech, sugar maple, cucumber, white ash, northern red oak, black cherry, and hawthorns, with strays of chestnut, chestnut oak, and other oaks.

Found on high, moist, northerly slopes and in high coves from West Virginia to northern Georgia, generally between 3,000 and 5,500 feet elevation.

5. *Northern red oak type*

Northern red oak pure or predominant. Common associates are black and chestnut oaks and chestnut.

High ridges and slopes at altitudes of from 2,500 to 5,500 feet.

6. *Cove hardwood type*

A groupwise or individual tree mixture of many species, of which chestnut, yellow poplar, northern red oak, white oak, and hemlock are probably the most characteristic throughout the region. The following species occur in varying quantities: basswood, white pine, buckeye, cucumber, white ash; bitternut, mockernut, pignut, and shagbark hickories; black cherry, black locust, black birch, black gum, black walnut, butternut, red maple, sycamore, mulberry, dogwood, and, in the southern part of the region, silverbell and sourwood. Other species more characteristic of the northern hardwood and the oak types may also be found. There are many variants of the cove hardwood type, distinguished by the predominance of one or another species. On soils derived from limestone, as in eastern Tennessee and Kentucky, chinquapin oak occurs, together with honey locust and coffee trees. Because of the importance of yellow poplar, pure stands of this species or mixtures in which it predominates are distinguished as a separate type. Similarly stands in which hemlock is predominant are designated hemlock type.

This type occupies moist coves or ravines with their adjacent lower slopes, sometimes extending for some distance up protected slopes of

north exposure. Altitudinal range, in the north, from 500 to 3,000 feet; in the southern mountains, from 1,200 to 3,800 feet.

7. *Yellow poplar type*

Yellow poplar pure or predominant. This type includes the stands of pure second-growth yellow poplar. Associates include all the cove frequenting species. Specific variants which have been described are: yellow poplar-chestnut, and yellow poplar-white oak (Shields and Wasilik for the Nantahala National Forest); yellow poplar-white oak-black gum-red maple (Ashe, Journal of the Elisha Mitchell Scientific Society, Vol. 37, March, 1922); yellow poplar-white oak-sugar maple (Ashe, loc. cit., for middle Kentucky and Tennessee, southward to Sand Mountain in northern Alabama, much of it on limestone soil); yellow poplar-white oak-black oak-white hickory (Ashe, loc. cit., for the Cumberland Mountains in Tennessee and Sand Mountain in Alabama, typically on sandy, often calcareous soils). The type tends to increase in area by replacing other species, particularly chestnut, after logging.

Found throughout the region on moist lower slopes, moist flats, and in coves, at altitudes of from 500 feet (or less in the northern Piedmont) to 3,800 feet in the mountains.

8. *Cove hemlock type*

Hemlock nearly pure or predominant, associated with the species enumerated for the northern hardwood and the cove hardwood types. The original stand was probably the same, in places, as the white pine-hemlock type of Pennsylvania, as in Shady Valley, Unaka National Forest. Transition mixtures are: hemlock-white oak (Marsh, for the Shenandoah National Forest); hemlock-yellow poplar; and white pine-hemlock (Stoneburner for the Unaka National Forest).

Found in coves and on moist lower slopes of northerly aspect at altitudes below 3,500 feet in the southern and 2,500 feet in the northern part of the region. Above these altitudes the type becomes more distinctly the hemlock-yellow birch type through the general occurrence of northern rather than southern associated species.

9. *White pine type*

White pine pure or predominant. Now practically restricted, as a type, to pure stands of second-growth, widely scattered at lower elevations in the mountains and valleys. A transition mixture is white pine-hemlock (Stoneburner, for the Unaka National Forest).

Found at elevations of from 1,500 to 4,000 feet or more (4,700 feet on Big Butt Mountain, Pisgah National Forest). Ashe describes

this type as formerly best developed between 3,000 and 4,000 feet in Tennessee and North Carolina (500 and 2,000 feet in Pennsylvania), on sandy or gravelly soils, inter-grading in many places with cove hemlock or with chestnut and white oak.

10. Chestnut type

Chestnut in pure stands or predominating in mixed stands. Common associates in the mountains are chestnut oak, yellow poplar, northern red oak, white oak, black oak, scarlet oak, hickories, black gum, black birch, basswood, sugar maple, and beech. In the northern Piedmont, scarlet, black, and southern red oaks, hickories, and Virginia pine are common associates of chestnut.

Extreme northern part of the Piedmont Plateau in Maryland and northern Virginia; elsewhere almost exclusively a mountain type, principally on northerly exposures, at altitudes of from 1,300 to 4,500 feet. Also on southerly exposures of from 4,000 to 5,500 feet of elevation in the southern mountains. Located, according to Ashe (loc. cit.), on acid soils from gneiss, metamorphosed sandstone, and sandstone deficient in lime and potash; top soils often semi-peaty, Porter black loam of the Bureau of Soils series.

The chestnut type will undoubtedly disappear through the death of the chestnut from chestnut blight. Its place will be taken by various associated species, varying with the nature of the site. The direction which this replacement will take as to the extension of already existing types can not now be foretold. Chestnut oak appears to be one of the most abundant species in the replacement.

11. White oak type

White oak predominant. The wide extent of the type gives it a great variety of associated species, including nearly all the common upland trees of the region, notably black, red, scarlet, and chestnut oaks, and chestnut.

Benches and lower slopes in the Appalachian, Cumberland, and Alleghany mountains, and in coves; better soils of the Piedmont and the valleys. Best developed below altitudes of 3,500 feet in the south, lower in the northern part of the region. Described by Ashe (loc. cit.) as especially developed on the drier soils derived from shales and located to the west of the Blue Ridge, but also along and east of the Blue Ridge in northern Virginia and northward. Described by Marsh, for the Shenandoah National Forest, as occurring at lower elevations in wide flats or second bottoms and along small streams.

12. Chestnut oak type

Chestnut oak nearly pure or as the predominant species in mixed stands. Common associates are chestnut, pitch pine, black oak, scarlet oak, black locust, Virginia pine, shortleaf pine, and southern red oak, the three last named chiefly on the plateaus. The sprouting capacity of chestnut oak tends to increase its percentage in mixed stands following cutting.

Mostly a mountain type, occupying southerly and dry northerly slopes and ridges from altitudes of 5,000 feet in the mountains to a little above sea level in the northeastern part of the region. According to Ashe (loc. cit.) located especially on soils derived from sandstone and shale.

13. Mountain oak type

A groupwise or individual tree mixture of dry site oaks characteristic of the mountains—notably black, scarlet, chestnut, and white oaks—other hardwoods and pines; the oaks predominating. Common associates of the oaks are hickories, black gum, chestnut, black locust, pitch pine, and table mountain pine. This type grades into the chestnut type extensively, and also into the pitch pine-mountain pine type.

A type characteristic of dry ridges and slopes, usually below altitudes of 4,000 feet. Distinguished from the plateau oak type by presence of chestnut oak, chestnut, and the mountain pines and absence of southern red oak and the plateau pines.

Pronounced variations exist, of which (a) *black oak* and (b) *scarlet oak stands* are noteworthy, marked by the predominance of black or of scarlet oak.

14. Pitch pine-mountain pine type

Pitch and table mountain pines in pure stands or, more commonly, associated with various dry site hardwoods, notably black, scarlet, and chestnut oaks, black gum, black locust and chestnut. Differentiated from the oak types by the predominance of pitch or table mountain pines, which also distinguishes this type from the pine types of the plateaus.

Appalachian and Cumberland Mountains from 2,000 to 5,000 feet elevation, on ridges and dry flats and slopes.

Composition varied. The following stands, named for the predominance of the species in them, are characteristic: (a) *pitch pine* and (b) *table mountain pine stands.*

Plateau Types

15. Plateau oak type

Mixtures—by individual trees, groups, or small stands—of black, scarlet, southern red, white and post oaks, and other hardwoods and pines; the oaks predominating. Black gum, hickories, shortleaf pine, and Virginia pine are common associates.

A type characteristic of dry sites on the plateaus, usually below 1,000 feet altitude in the northern part of the region, 2,500 feet in the southern, but reaching somewhat greater elevations in Georgia.

Variations exist, of which *southern red oak stands* are noteworthy.

16. Post oak type

Post oak predominant. An extensive plateau type, on dry sites, usually at elevations of between 500 and 1,500 feet. Commonly associated with other dry site oaks and with shortleaf pine, passing over into the shortleaf pine-post oak phase of the shortleaf pine type.

17. Shortleaf pine type

Shortleaf pine pure or predominating. Common associates are Virginia pine and the upland hardwoods characteristic of the Piedmont and Cumberland Plateaus and the larger valleys. Includes both old growth ("forest") and second-growth ("woods") shortleaf pine, designated on the Piedmont as "forest" and "woods" pine when in mixture with hardwoods (chiefly oaks). Loblolly pine is sometimes an associate in the southern parts of the region.

A plateau type, but found also in the Appalachian valleys and on low mountain slopes and ridges below about 2,500 feet elevation.

Ashe (loc. cit.) describes the following three variants:

(a) *Shortleaf pine-black oak-white hickory stands:* Abundant and widely distributed in the Piedmont, ascending to an altitude of 1,100 feet in the Valley of Virginia and 2,600 feet in the Asheville Basin.

(b) *Shortleaf pine-post oak stands:* Widely distributed in the Piedmont, but largely restricted in the mountains of North Carolina, Tennessee, and southward, to low ridges, not ascending above 2,500 feet in North Carolina.

(c) *Shortleaf pine-blackjack oak stands:* Widely distributed in the Piedmont, but limited, in the Appalachian mountains, to low ridges, seldom ascending above 2,000 feet in North Carolina, Tennessee, and southward, or 1,100 feet in Augusta County, Virginia.

18. Virginia pine type

Virginia pine *(Pinus virginiana)* pure or predominant. Abundant on old fields, particularly in Maryland and northern Virginia, but also

frequent throughout the Piedmont Plateau and lower mountain slopes and ridges into northern Georgia, below 2,000 and occasionally 3,000 feet elevation. Common associates are shortleaf pine and the upland hardwoods characteristic of the Piedmont and Cumberland Plateaus and the larger valleys. Ashe describes the following variant:

(a) *Virginia pine-chestnut oak-chestnut stands:* Most characteristic on points of shale and sandstone ridges in Kentucky and Tennessee, but also occurring to the northward on similar sites through extreme northeastern West Virginia and northern Virginia to Maryland. Also well developed in places on spurs of the Blue Ridge in western North Carolina and even occasionally as far south as Jasper County, Alabama.

19. Red cedar type

Red cedar pure or predominant. Mostly a plateau and valley type, well developed on limestone soils in the southern part of the Appalachian Valley and westward, in Tennessee, Alabama, and Georgia; found locally on the Piedmont Plateau.

20. River-edge hardwood type

A fringe forest along water courses and stream bottoms at altitudes below 2,500 feet at the southern end of the Appalachians, below 1,000 feet in Maryland. River birch, sycamore, black willow, and red maple are characteristic.

Coastal Plain Types

21. Loblolly pine type

Loblolly pine pure or predominant. Coastal Plain, southern part of adjoining Piedmont Plateau, and into the southern part of the Appalachian Valley. Variants include:

(a) *Flatwood stands:* Loblolly pine on the better drained sites in mixture with hardwoods in varying proportions up to 80 or 90 per cent. Associated species are oaks, hickories, red gum, etc. Soils are somewhat better drained than those of the swamp hardwood type. Abundant reproduction of all sizes is frequently found.

(b) *Pine barren stands:* Cut-over and burned-over lands which originally produced longleaf pine but which have been restocked with loblolly pine. The soils are usually coarse sandy loams.

(c) *Old field stands:* Usually pure stands of even-aged loblolly pine, sometimes mixed with a small percentage of longleaf pine, in the south. Soils of fair quality and usually well drained. Growth more rapid than on other sites.

(d) *Loblolly-shortleaf stands:* Groupwise or individual tree mixtures of the two species, a transition between the loblolly and shortleaf pine types.

22. Longleaf pine type

Longleaf pine pure or predominant. Southern part of the Coastal Plain and Piedmont Plateau in the Appalachian region.

There are three major variants:

(a) *Longleaf clay-hill stands:* Longleaf mixed with hardwoods occurs on clay and gravelly hills all along the Piedmont border of the Coastal Plain region, originally from as far north as Virginia. Associated species are the various Piedmont oaks, hickories, etc., and sometimes shortleaf and loblolly pines. Reproduction usually exceedingly poor, and longleaf is apparently receding to the true Coastal Plain areas.

(b) *Longleaf sand-hill stands:* Includes the sand-hill areas of North and South Carolina and similar areas of coarse sand to the east and south of the sand-hills. Longleaf pine is succeeded by turkey oak *(Quercus catesbei)* and, where the sand in somewhat less coarse, by the sand hill post oak *(Quercus stellata* var. *margaretta* Sarg.*)*.

(c) *Longleaf flat stands:* Longleaf on the rather low crawfish lands of the Coastal Plain which have been mostly burned over until, in some instances, there are only occasional cull trees left to identify the stands as belonging to the longleaf pine type. Reproduction is usually good where hogs and fire are kept out and seed trees are available.

23. Bottomland hardwood type

Mixed forests characterized by water oak, willow oak, red gum, yellow poplar, overcup oak, white oak, southern red oak, elms, ashes, red maple, and other lowland species. A type characteristic of the Piedmont as well as of the Coastal Plain. Found on damp or moist deep alluvial loams or sandy loams, generally inundated during the spring. There are many variants, of which

(a) *Red gum stands* are important as second-growth in many places.

Ashe (loc. cit.) recognizes two types, here regarded as stands within the general type:

(b) *Red gum-swamp southern red oak-spotted oak-black gum-Acer tridens-green ash-Celtis laevigata stands,* occurring along alluvials of larger streams at the southern end of the Appalachians at altitudes of 2,000 feet or less.

(c) *Red gum-white oak-black gum-shagbark hickory-sycamore stands,* occurring on alluvials, chiefly of smaller streams, at altitudes below 3,000 feet in northern Georgia and below 1,000 feet in the moun-

tains of Virginia (thus extending well into or through the Piedmont Plateau).

24. Swamp hardwood type

A varying mixture in which, in the south, tupelo, water gum, and red maple are usually the principal species, associated with yellow poplar, water ash, black gum, and swamp cottonwood, and often more or less cypress and occasionally loblolly pine. Farther south a cypress-tupelo mixture is characteristic and important.

Coastal swamps with usually rich clay soil, as distinguished from the soils of the southern white cedar and pond pine types.

25. Southern white cedar type

Southern white cedar pure or predominant. A local but valuable type, covering considerable areas in the aggregate. Common associates for the region are water gum, red maple, white bay, red bay, pond pine, and cypress. A second-growth type, largely in even-aged stands occupying sand-bottomed, usually peaty swamps in the Coastal Plain.

26. Pond pine type

Pond pine pure or predominant. Common associates are white bay, red bay, loblolly bay, and less frequently small black gum and loblolly pine.

Eastern Coastal Plain of southeastern Virginia and southward, in "pocosins"—swamps or semi-swamps having an impervious hard-pan of clay or silt, underlying the top soil, or having a badly depleted soil of coarse sand or silty finer sand.

27. Live oak type

A mixture of upland willow oak, Carolina cherry, yopon, holly, red cedar, hickory, and sometimes loblolly pine, in which live oak is the index tree rather than forming a large proportion of the forest growth.

Found on wind blown sands of the "banks" back from the beaches along the shore in North Carolina and southward, and on similar sites on the mainland.

WEATHER INJURY TO TERMINAL BUDS OF SCOTCH PINE AND OTHER CONIFERS

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The following is submitted as a re-interpretation of certain conclusions[1] of the senior author regarding the susceptibility of Scotch pine to the attacks of white pine weevil. In the course of an investigation of the growth of this species in plantations at Great Bear Springs, Oswego Co., New York, a rather high degree of weevil infestations was reported as being present. It remained for the junior author, in a special investigation of the insect itself, to point out the fact that the greater part of these so-called weevil injuries were of a pathological character not due to insect agency. He believed them caused by some other agency, probably frost.

Two conflicting opinions regarding the same injury demanded some investigation. To this end this special study was jointly undertaken. It should be pointed out that the results of the two forms of injury are extremely alike in appearance, and even during the first year can only be told apart through the close examination entailed in climbing and examining individual trees. Furthermore, injuries of more than five years' standing can not be distinguished except by inference and deduction.

Weevil injury always occurs in the previous year's growth, generally in the leader, but occasionally in an upright lateral which is striving for leadership. It arises from the activities of the newly hatched larvae of the insect feeding on the inner tissues of the leading shoot. Eggs are never laid in the buds but below the bud whorl in the upper part of the leader, before the new growth begins. The new growth starts normally, but soon after the weevil larvae become active, it wilts and turns brown. By about July 1, the leader dies and the tip curves over and hangs down. At least two years' growth of the main stem will be directly killed by the larval activity, and often three years' and occasionally four years' growth is killed. The living whorl of laterals next below the dead stem begins to strive for leadership, and a crook or crotch results. In dense stands one lateral usually gains

[1] The Control of White Pine Weevil *(Pissodes strobi)* by Mixed Planting, by H. C. Belyea—Journal of Forestry, Vol. XXI, No. 4, April, 1923.

the supremacy, and while a crook results, the tree will often straighten out in a degree.

In contrast to weevil injury, frost injury may occur not only at the apex but in the leading shoot of any primary or secondary branch of the tree. As an injury to tree growth, it is of main importance, however, when it occurs in the leading shoot of the main axis. Further, its action is centered in and confined to the bud whorl. The entire whorl or only the apical bud may be killed. In the former case the entire leader eventually dies back to the previous years' growth of laterals, from whence comes one or more laterals striving for leadership. A dead stub results, and at a casual glance may be mistaken for a weeviled leader. However, if closely examined it will be seen that there are no exit holes as found in weeviled leaders, and after the first summer the bark remains on the wood whereas in a weeviled leader the bark begins to peel off the year after injury. If the apical bud alone is killed the lateral buds begin to grow and a broom-like mass of leaders is formed. At the same time an abnormal growth of needles comes out of the leader just below the terminal whorl and the characteristic appearance is roughly that of a round paint brush. The drooping tips will be evident in weeviled trees for one or two years after the injury, while in a frost-injured tree there will be no wilted tip, but there will be a dead leader or this "paint-brush" leader.

The susceptibility of Scotch pine to frost injury was first reported by Hartig (1) in 1895. His study very ably developed the correlation with this injury of double growth rings in the stem. Similar studies with similar conclusions in species other than Scotch pine have been carried on by several investigators, notably Neger (2), Somerville (3), Lubeuf (4), Rhoades (5), and others. Briefly the same phenomenon described by these various writers was approximated by the trees of this study. This development, however, did not so much approach the "S" forms of the *Pinus densiflora* of Rhoades as it approximated the laxity of the wilted twigs of Hartig with a supplementary bending of the twig axis during the development of a new leading shoot. This latter is of importance because it is in this development that the injury takes the form of and is apt to be mistaken for the injury of the white pine weevil.

With the distinctions between the two types of injury clearly in mind, examination of certain of the plantations of Great Bear Springs was undertaken. Sample plots were laid out with a number of varia-

tions of planting and of exposure. All trees were examined and the occurrence of either insect injury or frost injury noted and correlated to the year of its occurrence by a node count *from the top downward.*

In eight Scotch pine plantations, mainly six-foot by six-foot spacing, it was found that from 55 to 77 per cent. of the trees were affected by the injury occurring definitely in four distinct years: 1917, 1920, 1921, 1922. The amount for the year 1917 was rather light, about eight per cent.; the year 1920, rather heavy, about 40 per cent.; and the balance about equally divided between the other two years. In five mixed plantations of white and Scotch pine planted six-foot by six-foot in alternate rows, white pine on the average suffered only 10.8 per cent., while the Scotch pine suffered to the extent of 70 per cent. of the trees. With white pine 94 per cent. of the injury occurred in 1920 while with Scotch pine it was noticeably heavier in 1920, less in 1921 and 1922 and least in 1917.

The question immediately arose as to whether the occurrence of this injury was confined only to Scotch pine or whether it was common to all of the pines, especially our American species, white pine, *Pinus strobus,* red pine, *Pinus resinosa,* and western yellow pine, *Pinus ponderosa*—plantings of all three species being available for examination at Great Bear Springs. The same field procedure was followed as before. The results are presented in Table 1.

Table No. 1

Observations of Frost Injury in Four Planted Species at Great Bear Springs, Oswego County, N. Y.

Species	No. of Trees per Acre	No. of Trees Injured	Total No. of Injuries	Average Injury Percentage	Injury by Years in Percentages of Total Injury 1917	1920	1921	1922
Pure Scotch Pine (Average of 8 plots)	1,260	744	917	59.4	8.1	36.4	28.6	26.9
Pure White Pine (Average of 5 plots)	986	141	143	13.9	12.8	73.3	10.3	3.6
Pure Western Yellow (Average of 5 plots)	896	102	104	13.5	7.2	49.0	38.6	5.2
Pure Red Pine (1 plot)	1,045	25	25	2.4	...	100.0	...	...

From the foregoing it would appear that Scotch pine is rather susceptible to frost injury under certain climatic conditions. Our native pines are also affected by this injury but to a much less extent than Scotch pine. Of our native pines red pine is affected the least.

Attention was then turned to the climatic factors and examination was made of the data available to see what influences were common

to early spring conditions in the years 1917, 1920, 1921, and 1922 and not to be found in the years 1916, 1918, 1919, and 1923. Specifically what was looked for were periods of warm sunny weather occurring earlier or later in April which might by their mildness and duration induce growing activity in the plant (especially in bud tissues on the ends of the branches), followed by a sudden drop in temperature to freezing conditions which might kill the growth so initiated.

From a study of these climatic data certain conditions were observed common to the four spring seasons of 1917, 1920, and 1922 in which the damage occurred, namely periods of fine weather accompanied by unseasonably high temperatures, followed by a sudden drop in temperature to or below the frost point for a period, followed in turn by a quick return to warm temperature. The length of the subfreezing period is not of particular importance so long as freezing temperatures prevailed, after relatively high seasonal temperatures have been experienced. The longer this period of warm temperatures the greater seems to have been the susceptibility to damage, as notably in spring of 1920 when more than a week of warm weather preceded the drop to freezing temperature. Furthermore, as evidenced in 1922, one day with freezing temperatures following such a warm spell seems to be all that is necessary to accomplish the injury. In seasons like those of April, 1921, and April, 1922, where there is a double rise and fall in temperature, it is probable the effect of the second cold spell is negative in character, the damage having been done during the first freezing period.

As to the effect of sunshine the indications are not so clear. Whether a sunshiny day immediately following the frost is detrimental or otherwise can not definitely be stated. It might be pointed out, however, that plots which showed the highest percentage of damage were easterly in their exposure while plots which show relatively the least amount of damage were westerly in their exposure. The inference is that in the former situations the early morning sun and heat thaws out the frozen tissues so rapidly as to shatter their structure while on westerly exposures the thawing process is accomplished at a much slower pace and in comparative safety.

In order definitely to check the theory of bud freezing as the cause of this pathological injury in the leaders of Scotch pine the following controlled laboratory experiment was undertaken. Three-year-old Scotch pine transplants were removed from the open nursery bed and

placed under glass in a heated room whose temperature remained between 65 to 70 degrees Fahrenheit at all times.

By the beginning of the third week it was seen that several of the apical buds had swelled and opened slightly. These buds were sprayed two or three times a day. About one month after transplanting the entire group of transplants was suddenly exposed to a freezing temperature. Previous to being exposed several of the opening buds were drenched with water and the remainder (opened as well as unopened buds) were allowed to remain dry.

At the end of two hours the transplants were taken inside and placed in the same position as before. Sections were then prepared for microscopic examination according to standard process. From this examination the following conclusions were drawn:

1. Buds, which were dry and unopened when frozen, were found to have normal structure and consequently were undamaged by the freezing and sudden thawing.

2. Buds which had partially opened and were wet when frozen showed a pronounced shattering of the tissues and a plasmolysis which probably resulted from the extraction of water which did not return when the tissues were thawed. This shows in all the cells, including the cortex, pith, phloem, and cambium of the young vascular bundles. There was an excessive plasmolysis, and it can be inferred that the growing points at the tips of the buds and the needles were similarly injured.

3. It is not unreasonable to assume that this same action would take place out of doors after the buds had begun to open, should alternate thawing and freezing occur. The opening buds are very tender and even a slight exposure to frost would be sufficient to kill the tissue if the subsequent thawing were rapid.

Summary

From the foregoing several conclusions may be drawn.

1. Frost injury, that is injury of the cellular structure of the live bud tissue due to freezing, may occur in several coniferous native and exotic species planted in central and western New York, following certain fairly well-defined climatic conditions.

2. This injury seems most excessive in Scotch pine, affecting from 60 to 70 per cent. of the trees. It may attack either the leading shoot of the main stem or the leading shoot of any branch. It is not uncommon to see several injuries on one tree all occurring in the same year.

3. This injury is in result very much like the injury from white pine weevil and can be distinguished from it only by careful examination of individual trees.

4. Probably not less than 75 per cent. of the injury previously reported for Scotch pine as weevil injury may have been due to frost rather than to the insect.

5. The climatic conditions which cause this injury seem to be an early and continued series of fine warm days of sufficient intensity to induce growth in the apical buds, followed by a drop to freezing temperatures, which in turn is followed by a return to high temperatures.

6. The duration of the freezing period is not of as much importance as its intensity.

7. There seems to be absolutely no control for this injury.

8. It is suggested, however, that the origin of the seed of the trees might throw some light on the matter, it being the belief of the writers that stock originating from Germany as did the seed used in this particular case is probably less hardy, less adapted to our central New York April climatic extremes than stock originating from more northern seed, Swedish for instance.

9. It is believed that this study will only be complete when a study along the lines suggested by No. 8 is undertaken and completed.

10. Nothing in this, however, is believed to detract from the protective value against weevil of Scotch pine planted in mixture with white pine. There is undoubtedly a lessened weevil infestation in the white pine but it is not due to the Scotch pine acting as a "trap tree." It is more probably due to the rapid growing and taller Scotch pine forcing the insect to higher and wider flights. The fact remains that mixed planting with Scotch pine seems to give the white pine associate a desirable measure of protection against the weevil.

MICROMETER SLIDE ADAPTED TO CORE MEASURING

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U. S. Bureau of Entomology

Increment cores are now being used by a number of foresters and forest entomologists for a variety of purposes. The forest entomologist is at present concerned with them chiefly as an index to the vigor of the trees as related to insect attacks. The measurement of a large series of cores with consistent accuracy has been difficult and has required much time. To facilitate the accurate measurement of these cores the instrument shown in the accompanying diagram was evolved at the Palo Alto Station of the Bureau of Entomology.*

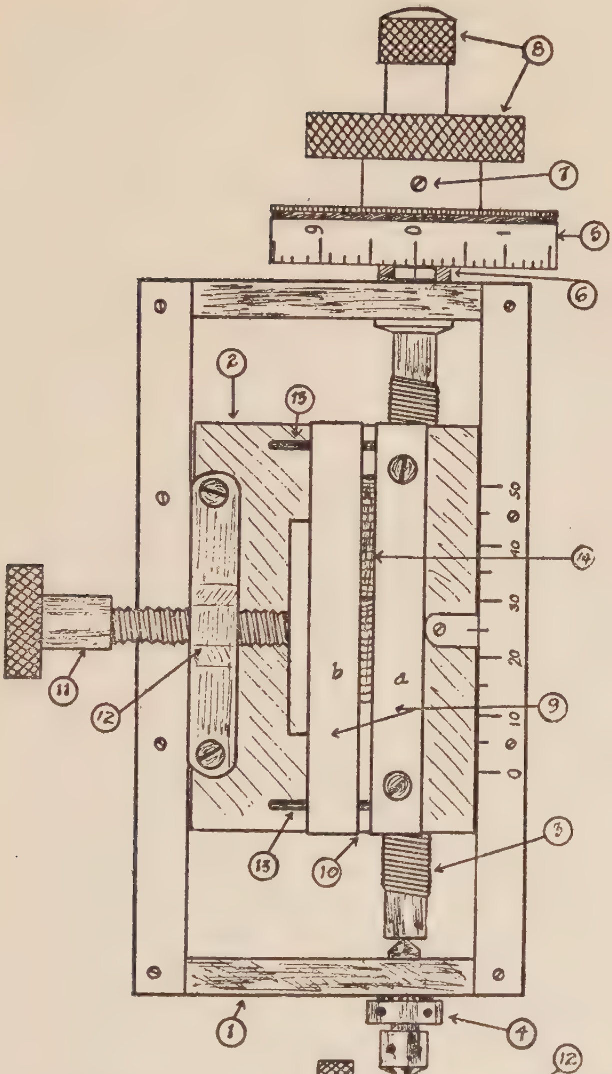
The important part of this increment comparator is the Model M301 Micrometer Slide, manufactured by a corporation in Chicago which makes scientific instruments. To make the micrometer slide a convenient instrument for measuring the radial increment of cores, adjustable jaws were attached to the movable stage of the slide. The function of these jaws is to hold the increment core, which is mechanically shifted across the field of a microscope, and in this way the width of annual growth rings is accurately measured under magnification. The jaws also serve to hold the core while it is being prepared for measuring.

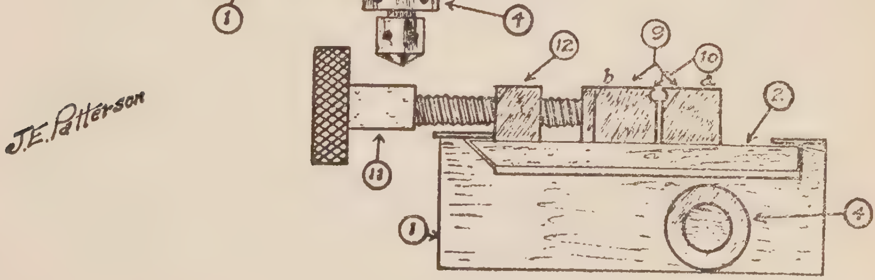
The separate parts of the assembled instrument are given on the diagram under explanation of parts. These parts are drawn to exact scale. The function of each will be understood by studying the following directions for using the comparator. The only parts adapted to the trade instrument are the core-holding jaws and their adjusting screw and nut. All are made of brass and are illustrated in the diagram under Figs. 9, 10, 11, 12, and 13. Fig. 14 shows an increment core between the jaws and in position for measuring.

The Comparator in Use: The assembled instrument, as diagramed, is mounted on the stage of a stereoprism binocular microscope with the groove opening between the jaws cutting the center of the microscope field. An increment core is placed in the groove (Fig. 10) of the jaws. The movable jaw (9b) is then closed by turning the tightening screw head (Fig. 11). This movement firmly grips the core between

*Officials of the U. S. Bureau of Standards kindly assisted by demonstrating comparators in use in their laboratory and by describing other instruments which might be suitable for our purposes.—F. C. CRAIGHEAD.

the jaws. A section of the core—about one-fifth of its cross section—will extend above the surface of the jaws. This core extension is shaved off with a sharp knife, leaving a smooth surface flush with the plane of the jaws and rendering the annual rings more distinct. The cores should be soaked in water previous to clamping on the jaws and shaving. The core is now ready for measuring the radial increment. This is done by shifting the stage (Fig. 2), including the clamped core, across the microscope field by turning the micrometer screw (Fig. 3) by either one of the knurled discs (Fig. 8). A cross hair mounted in one ocular of the microscope serves as an indicator. As the core is shifted across the field sight readings are taken where the edges of the annual rings coincide with this cross hair. The width of the rings is mechanically measured and registered on the perimeter of the micrometer head (Fig. 5). This vernier head is mounted on the shaft of the micrometer screw by a friction thrust pin which allows the head to be manually rotated without turning the screw but which also holds the head with sufficient tension so that it revolves with the screw when the latter is turned by the discs (8). In measuring the width of growth rings the vernier on the micrometer head is first set at zero for each measurement. The micrometer screw has a thread pitch of 1mm., and as the micrometer head is set off with 100 divisions, accurate readings to 1/100 mm. are ordinary practice.





Explanation of Parts of Comparator

1—Base of instrument.

2—Sliding stage.

3—Micrometer screw.

4—Thrust pin and lock.

5—Micrometer head for recording shift of stage. Vernier engraved in 1/100 mm.

6—Position indicator.

7—Friction screw.

8—Knurled discs for turning micrometer screw.

9—Jaw clamps for holding increment cores.
 (a) Stationary member.
 (b) Sliding member.

10—Groove for core.

11—Jaw clamping screw.

12—Stationary screw nut.

13—Guides for jaws.

14—Increment core.

The Determination of Increment in Cut-over Stands of Western Yellow Pine in Arizona. By Herman Krauch, Jour. Agr. Res. XXXII, 6, March 15, 1926. pp. 501-542.

The reviewer has been convinced, since an early reading of this report in manuscript form, that its implications were misleading, and because it has been published in the same tone, feels compelled to criticize it severely.

The measurement of increment on sample areas is one thing; the application of the resultant figures to more extensive areas is quite another. Each is fraught with its difficulties and dangers. What the author has done in this case is to describe, as a part of the process of determining increment, merely one of the possible methods for applying the results.

The stands were tallied, tagged and calipered completely on small or "intensive" sample plots about 1910, and were again calipered after an interval of ten years. The changes in diameter for trees of several diameter groups give the basis for computing changes in volume, the volume curves used being based on diameter only, which is not a serious weakness when changes in *form* occurring in only ten years, are involved.

On more "extensive" plots surrounding the small ones all of the trees were tallied at the outset to form a more comprehensive and normal stand table for the type, and a means for keeping account of mortalities in a representative stand. With one exception these trees were not tagged at the outset, so that individual remeasurements at the end of the decade were impossible. With this exception, then, the original stand tables for these larger plots can be used only as *something to which the measured increments of the "intensive" plots may be applied.* The author recognizes, also, the need for tagging every tree in order to have a thoroughly accurate record of mortalities. Without this provision there is certain to be confusion and lack of accuracy in the records. On the other hand we may well find fault with the recommendation that only a portion of the trees so tagged be periodically remeasured for growth. It would seem that when the degree of variation between the average growth rates of a few trees and of many trees, is considered (as shown in Table III) the need for the greatest possible number of growth determinations would be apparent, and the suggestion

of a short-cut method would be set aside. This is the more vital when we consider that any kind of a selective method for trees to be measured is certain to give misleading results—usually too optimistic—since it seems to be humanly impossible to choose "average" trees even when such an arbitrary basis is set down as the taking of every fifth tree for a sample. Furthermore, even for an acceptable record of mortalities, repeated calipering is necessary. It makes a good deal of difference in the calculation of volume losses whether trees die at the size originally measured, or at a considerably larger size 20 years later.

The major questions concerning this paper are as to whether the method of application proposed should be considered a part of the increment determination, and whether the method is, in itself, the best application of the data. Obviously there must be a method of application to stands in general, or the study is futile, as many are coming to realize after exhaustive work spent in the preparation of "yield tables" of one kind or another.

Regarding the first question the reviewer maintains that the scheme is wrong in principle, since it is a well established fact that the greater the number of trees per acre the less must be the diameter and volume growth per tree, at least within wide limits as to stocking. Nothing can be more faulty than the conception that under a variety of growing conditions a 16-inch tree will show a certain performance simply because it is a 16-inch tree. There is no standard of conduct for 16-inch trees as such. And nothing will influence their performance more certainly than the character of surrounding trees, which must usually be expressed by a stand table or diagram. It therefore goes almost without saying that the growth curve (diameter increase on d. b. h.) is individual for each stand, according to the character of its stocking, and can have no close application to any other stand. This should be especially true in the yellow pine stands of the Southwest where variations in stocking are an outstanding characteristic. The error in principle is well enough illustrated in Table III which the author uses to show that the diameter growth *rate* on the intensive and more extensive plots can not be very different. Under each of the three methods cited the diameter growth of 12 to 20-inch trees was greater, on the intensive plots, than that of the group of smaller trees, which would in itself be considered an abnormal condition in most stands. The records of the extensive areas show that it is an abnormal condition for yellow pine on this site, at least. But whether or not such an

abnormality, occurring in the smaller group of data, were detectable, the principle would remain the same. The diameter increases of a certain group of trees are too much influenced by the position of that group in the stand. It is, therefore, evident, that their application to the more extensive stand tables is not a step toward adding strength to the original data. On the other hand, if, for example, one out of every five trees of the extensive stand had been measured, such measurements might be safely applied to the other four trees of the same diameter group. This is essentially the author's proposal in his strip method for future use.

As to whether the method of extending diameter gains to unmeasured stands gives an essentially correct result in total increment per acre, there is perhaps less question. The diameter gains measured will be too high if applied to stands of heavier stocking than the intensive plots, too low if applied to lighter stands where each tree has greater opportunity. The author criticizes the method of transporting the increment-per-acre figure from one stand to another, maintaining that for a given site total increment per acre is uniform only under conditions of full and uniform stocking such as may exist in well-managed forests. This is true to some extent: the increment per acre, at least for a considerable time after cutting, certainly decreases with the degree of stocking, within wide limits, though tending always to progress to a normal either through enlargement of the older trees left or through accessions of young growth.

In view of these facts, a combination or mean result of the two methods of applying increment data to such stands as those in the Southwest, would appear to promise a very close approximation to the actual increments of extensive areas. Krauch's method of transferring diameter gains *in toto* from a few trees to the many, of course implies extensive stand tables, while the other method involves only forested area.

One other criticism might well be made since it involves a circuitous, involved type of approach which does not indicate clear thinking and is conducive only to confusion. This is the double volume curve as illustrated in Fig. 4. The reviewer is unable to comprehend why the volume of a 15.66-inch tree or a 16.67-inch tree, as well as that of the original 15-inch tree, can not be read as well from the single curve as from three curves. If it is desired to illustrate graphically the degree of change in volume, tree-increment curves as given in

earlier diagrams are certainly much more effective and precise. As a matter of fact a table giving volumes for each tenth-inch in diameter is the only proper basis for computing volumes.

There should be a fairly obvious reason for reviewing this paper in some of its more important principles, rather than with reference to its results, which are probably sufficiently accurate for any present use. At this stage no one is very much concerned as to whether the increment rate of yellow pine in the Southwest is 4 or 30 cubic feet per acre (Table IV). It is sufficient to know that it is of a low order. On the other hand, at the present time a great many permanent sample plots are being established by foresters. It is important that erroneous principles should not guide the initial steps, for those steps can not be recalled 10 or 20 years hence when precise growth data may be sorely needed.

C. G. BATES

The Changing Evaporation-Precipitation Cycle of North China. W. C. Lowdermilk. Engineering Society of China—Session 1925-26. Paper No. 5, Vol. XXV. Pages 34—2 maps, 12 plates.

This is a preliminary paper giving the results of run-off measurements on five sets of contrasted plots in the province of Shansi, northern China, together with a discussion of the theory that an excess in run-off, by carrying to the sea large quantities of water formerly held in the region by evaporation, ultimately reduces the total rainfall of the region, thus contributing to its dessication and depopulation.

Locations for the plots were difficult to find owing to the almost complete destruction of the forest by cultivation of the mountain sides, but those that were secured showed ratios of run-off on non-forested slopes compared with forested, of 57 to 1 on one set of two plots, and 78 to 1 on three other sets of two plots, while the final set was wholly in a forested area and showed no silting or sediment in the streams. In some cases for single storms the contrast was as high as 1,505 to 1. These differences, due to denudation, grade from these extremes to zero, but the sum of the excess run-off is somewhere between the extremes and introduces a factor into the equation between run-off and rainfall which means annual loss of water from the region.

The pamphlet strengthens Zon's original discussion of the subject published in 1913 as Senate Document 469-62, entitled "Forest and Waters in the Light of Scientific Investigations," first appearing in an article delivered before the Society, December 14, 1911, and pub-

lished in 1913 in Vol. 8 of the Proceedings. Mr. Lowdermilk's article cites some 32 references to various phases of the subject. The contribution is especially interesting in the new light which it throws on the controversy between certain engineers and meteorologists who deny the influence of forests on rainfall in toto and those who of late have come to investigate more logically the source of moisture which supplies the rains of interior continental areas.

H. H. CHAPMAN

Third Report on a Forest Survey of Illinois. By Clarence J. Telford. Pages 202, 9 Plates.

This report gives the results of the most comprehensive survey of its forest resources ever attempted by any state in the knowledge of the reviewer. The area of woodlands in Illinois has been mapped wherever woodland existed to any appreciable per cent. The results are given in four loose maps with a cut showing the original distribution of woodlands in the state. Descriptions of prevalent types and stands are included. Part II is of even greater interest to foresters, as it contains the results of a very comprehensive study of growth and yields of Illinois hardwoods, which compose the forest types of the state almost exclusively.

These studies have been in every instance correlated with standard soil types. The studies of growth rates for individual trees have given some striking results. It was found that (1) on the same soil type, trees grew most rapidly when in even-aged stands, and (2) that there may be great differences in the period required to produce a tree of a given size, for different species; (3) which difference may exceed that for the same species on different soil types. Hickory showed the least difference in growth between even- and all-aged stands, while white oak and ash gave the greatest. On the same soil type, the period for different species to reach a 10-inch stump varied from 8 years for cottonwood to 101 years for elm. The fastest growers were the cottonwood, white pine, water and honey locusts, black locust, black walnut, tulip poplar and pin oak in the order named while the slowest were elm, hickory, tupelo gum, and white oak. Soils made a difference up to 70 per cent. in the period required for white oak, other species showing less differences; with hickory the least. Cubic volume growth showed astonishing differences between species for periods of 20 years. On upland soils this varied from white pine, even-aged, 63.6 cubic feet, to beech, all-aged, 2.5 cubic feet, with black walnut all-aged, 51.5

cubic feet giving the best growth for hardwoods. On bottom-land soils cottonwood, even-aged, gave 96.7 cubic feet, with sycamore 62.9 and soft maple 53.0 while elm gave but 2.0 in all-aged stands, and hickory but 1.5 cubic feet. The rapid growth of water and honey locusts, at 28.5 and 25.8 cubic feet, is noteworthy. The black oaks occupy an intermediate place, between 27 and 11 cubic feet except on heavy acid clay soils where they drop from 8 to 4 cubic feet.

On upland yellow silt loams the technical rotation for a tree with 70-inch stump d. i. b. is 60 years for tulip poplar, red and black oaks, and ash, while white oak, hickory and hard maple grow very slowly. On sand, white pine and black oak give this same rotation. On bottomland soils, 40 years gives heavy yields of sycamore, cottonwood and soft maple but elm fails to produce merchantable sizes. On heavy bottomlands, water and honey locusts, pin oak and soft maple yield merchantable products in this time, but ash, hickory, elm, tupelo and Spanish oak do not.

Plots taken for yield to the number of 104 showed by comparison with yields for Connecticut hardwoods that the lesser rainfall of Illinois, 37 inches as against Connecticut's 47 inches, was reflected in lower yields and a smaller number of trees per acre for post oak and black oak mixtures; the yield of post oak land being less than that of third quality oak in Connecticut.

Yields in this type gave an average annual increment of from 12.5 to 17 cubic feet. Scrub oak types gave 22.5 to 29.2 cubic feet per year, while upland hardwoods yielded 34.2 to 40.5 cubic feet. On bottomlands, the rapidly growing species gave from 88 to 122 cubic feet per year, while the slow growing species enumerated above yielded 37.5 to 54 cubic feet.

Virgin stands, in a state of equilibrium between growth and decay, averaged between 94.5 and 101.6 square feet of basal area, and between 3,053 and 3,297 cubic feet without bark, at 90 and 80 years, respectively, for uplands and bottomlands. The mean annual increment culminates before 20 years and drops steadily thereafter. The yields at 70 years for fast growing hardwoods on bottomlands are 6,150 cubic feet or, at 86 feet per cord, 71 cords per acre or 14,000 board feet, while for uplands, the yield at 100 years does not exceed 3,425 cubic feet, equal to 40 cords or 8,000 board feet. The average possible yield of wood is given as 41.1 cubic feet per year, if fully stocked, comparable with a present drain of 44.7 cubic feet from the forests.

Conclusions are drawn which indicate that the best opportunity for state owned forests is in sandy areas of which there are 310,000 acres and on three areas of hardwood forests in the southern position of the state approximating 202,000, 86,000 and 50,000 acres, respectively. Elsewhere the problem is purely one of encouraging woodlot forestry by private owners and of restocking the forest on some 1,577,663 acres of abandoned or waste land by planting, also a private enterprise because of its scattered and small units. The farm woodlots of the state hold the main prospect for future wood supplies for Illinois.

H. H. C.

Investigations in Tree Form (Nagra Undersokningar Over Stamformen). By L. Tiren, Skogsvardsforeningens Tidskrift 24:23-88, Fig. 1-27, 1926.

In order to compute the pressure of the wind on large trees and by calculations of mechanics check Metzger's hypothesis of tree form, it was necessary to know the area of the crown and trunk in all its components.

This was accomplished by weighing all branches and determining the area exposed by the needles, twigs, etc., per unit of weight. Needles proved the most difficult to measure with exactness. For determining the thickness micrometer screws and microphotographs of cross sections were used. Volumes were checked by displacement tests in special capillary tubes. It was found that two different needle-types could be distinguished, "sun-needles" and "shade-needles," the latter having the greatest area per unit weight. Curves were constructed showing the relation of needle surface to weight and volume for different parts of the crown. After selecting sample branches, the number of needles per unit of branch length was determined by counting 300 to 1,000 needles in different sections of the branch. The thicknesses of needles in various parts of each branch were measured in order that they might be assigned to proper area classes. By applying the proper curves the total area of needles per unit of branch length for each type of branch was then determined, and the total area of all needles on the tree computed by comparison of branch weights. Similarly the area of bare branches was determined by first finding the area in square centimeters per gram of the total weight of branch.

Direct measurement of wind pressures was made on branches of various types and of known area, using a wind tunnel with measured wind velocities. From these tests it became apparent that wind pres-

sures on tree crowns are not proportional to a constant power of the wind velocity as in the case of plane surfaces, but that they vary with the stiffness of the branches, the type of branching, their size, number of needles, and other factors. In light winds which scarcely bend the branches the ordinary formula for wind pressure is applicable. For instance the stiffest and coarsest branches in thin-crowned trees offer a resistance of one kg. per square m. with wind velocities of 20 m. per second, while the thicker and softer branches oppose the wind with only about .4 kg. per square m.

Neglecting the angle of the branches to the bole in a vertical plane, bending equations for simple cylinders permitted the calculation of the position of the form point within one per cent. of its position as found by actual measurement. Further tests were made in the field in which photographs with fixed camera were taken of trees in a calm, and when bent by violent gusts. The wind velocities during the gusts were measured by instruments mounted near the trees at the height of form point. In addition recording apparatus was attached to the bases of the trees by which the bending strains and fibre compression were measured. In these ways it was possible to take elasticity into account in the computations. Again remarkably good agreement with direct measurement was secured, indicating that the laws of mechanics are applicable to studies of tree form.

As a check, stresses other than wind pressures which might affect tree form such as compression, bending and shearing due to the weight of the bole and crown alone were calculated, but were found to be of negligible amount as compared to wind pressure. Torsion, however, in exceptional trees with one-sided crowns, may be of considerable importance.

During the study the importance of considering absolute quantities became apparent, and evidence seems conclusive that the form of tree stems is dependent on the prevailing wind velocity for the locality of growth, and that the form point theory is founded on some fundamental natural law.

H. I. B.

Lundh, Erik. Produktionsundersokningar a Avdikade Marker Inom Bjufors Kronopark (Production Investigations on Drained Lands in Bjufors Crown Forest) Skogsvardsfor. Tid. 23:195-248, 315-348. Fig. 1-20, 1925.

Bjufors forest is especially well adapted to a study of the effect of draining on tree growth, since ditching of forest lands has been

in progress there on a very considerable scale since 1897. From an extended study of many sample plots, it has been found that draining has produced an improvement in the site quality of from two to four classes, and increased the growth in cubic meters per har. by double to six times what it was before ditching. Further changes in site quality may take place in the future, and renewal of ditches may occasionally be necessary at the time of reproduction cuttings. On account of lack of data no good correlation could be established between growth and climate, yet in the case of pine and spruce Hesselman's findings that the temperature of the previous summer determines height growth, while diameter growth is influenced by the temperature of the year, were well substantiated. With birch this is apparently not the case, even height growth being controlled by the temperature of the year. The capacity of spruce to put on greatly increased growth following draining was not found to diminish appreciably up to an age of 100 years at the time of ditching. The figures were 70 to 80 years for birch. Even trees which fail to increase in growth rate may aid in drying out the bog by their increased transpiration after ditching. The best species for growing on bare, drained bogs are undoubtedly pine and birch; their root systems occupy complementary regions of the soil, and improve its physical condition. No matter how poor they are, trees already growing on the bog should not be cut at the time of ditching, for any trees are better than none. Calculations to determine the increased money yields to be expected from draining were made from graded yield tables, separated as to site quality, character of products, and local market conditions, which were constructed for forest types similar to those studied on the sample plots. A standard density of .8 was assumed. In the case of forest already present, its economic age and not the actual age, was considered. The results of sample calculations show that even under more unfavorable conditions, the increased values of the yields show a very considerable margin over those of undrained bogs, after deducting all costs of draining.

HENRY I. BALDWIN

Meddelser fra Det Norske Skogforsoksvaesen (Reports of the Norwegian Forest Experiment Station). Vol. 6, 1925. Edited by Erling Eide.

This publication of 186 pages consists of two parts, the first a short report of the activities of the experiment station in 1925 by Erling Eide, the director. A number of new permanent sample plots were laid out during the year, following the example of the Swedish

Forest Experiment Station. These plots were established in connection with studies of (a) yields in even-aged stands; (b) selection forests; (c) plantations of exotics; (d) seed production; (e) sowing and planting experiments, and (f) influence of grazing on forests—which makes a pretty comprehensive program for Director Eide and his two assistants.

The major part of the report is devoted to an article by Ivar Jorstad, government mycologist, on the subject of "Norwegian Tree Diseases." This comprises a catalog or compilation of diseases grouped according to their host trees, which makes the work convenient for reference by foresters. It is the first of a series, the present dealing only with the diseases of the four native conifers, and some of the exotics. Among the rusts *Cronartium pini* is cited as being most serious, and frequently severely damages Scotch pine, but is far from being as destructive as the nearly-related *C. ribicola,* which has practically wiped out white pine in Norway, where blister rust has been known since 1885.

It is interesting to note a considerable number of references to various diseases which occur on American species planted in Norway. The significance of this will be grasped when it is remembered that our most destructive diseases have come from Europe, and that many of these diseases have come to be important in Europe only after the importation of American or other trees, which proved especially susceptible to them. While possessing many milder fungi, Norway seems to be fortunate in being without any one devastating disease. Sundry needle diseases and seedling blights such as damping off, together with their remedies, are briefly treated. The text is very completely annotated, and it is only regrettable that illustrations could not have accompanied the descriptions. The article is followed by an English résumé.

H. I. B.

Kienitz, M. Zur Saatgutsortierung (Forest Tree Seed Grading). Zeitschr. Forst.-u. Jagdw. 56:710-716. 1924.

Reference is made to Dr. Busse's article in the September, 1924, issue of this periodical in which sorting of seed by centrifuging, first by weight and then by size, is recommended. Admitting the advantage of strong seedlings, general application of the procedure must be viewed with apprehension. A grading of seed is necessary but it should first of all be determined whether this should be based upon weight. According to Engler the factor determining differences in growth is the climate

of the site of the mother tree. Even in agricultural work, which Busse refers to as an example, size of seed is not always considered in grading. Unlike the agriculturist the forester is not primarily concerned with seed production and size and weight of seeds, but with the procuring of certain qualities in his crop of trees. The character of the tree is important, size of seed subordinate. A comparison of seed and species is sufficient to prove that size of seed and eventual growth do not run hand in hand. In 1911, acorns were collected from various sessile oak individuals, in Chorin, in which crossing was reduced to a minimum because of their situation. The seedlings from these acorns were very similar for the same trees, but widely variant for different trees. One tall, slender mother tree produced uniform and good seed of very small size, while the largest seed was secured from an old cripple. The experiment was unfortunately terminated by the war. Inconclusive results confirmed the conviction that the characters of the mother trees are inherited to a large degree. It has been determined that the weight of pine and spruce seed decreases with increasing elevation above sea-level. Also the proportion of small-crowned slender forms of pine increases with rising elevation and with increasing latitude. It is believed, although not proven, that the small-crowned trees produce smaller seed than the coarser wide-crowned trees. A separation, as Busse recommends, can only be considered vital when the seed of one tree or that of a single, well-developed race, is considered. In mixed stands where all forms of trees are found, the weight and size of seed should not be a criterion for selection, else the small-crowned and desirable races would gradually be eliminated. Proper seed selection is best secured by careful thinning of stands, preferably entire ranges, in order to leave only select mother trees. Engler states that seed weight of spruce and other conifers is given undue importance, that it is more important to judge quality by a knowledge of the source of the seed, and its germinability.

J. Roeser

Hausendorf, R. Die Vorratspflege in den Sachsischen und in den Preussischen Staatsforsten (The Care of the Growing Stock in the Saxon and Prussian State Forests). Zeitschr. Forst.-u. Jagdw. 56:607-616. 1924.

The history of forest management in Saxony illustrates the danger of over-utilization to which the growing stock of state forests is subjected. During the Napoleonic Wars, the stands had been considerably depleted. To correct this, the rotation was lengthened to 110 and

finally to 116 years, and a gradual upbuilding of the growing stock was secured. Then came Pressler and his theory of the highest interest on forest capital in the 70's. He established a financial 85-year rotation for the state forests. The removal of a large area of over-mature timber occasioned the introduction of the clear-cutting system. As it worked out, the rotation actually employed was 81 years. The reduction from 116 years to 81 years in a 40-year period resulted in a serious reduction of the growing stock. In recent years, technical opinion has gradually retreated from the purely mathematical standpoint concerning the rotation period and the tendency to prolong it has increased in favor. Martin points out that the application of a strictly mathematical method without consideration of physical factors is not desirable, because the factors governing the calculation of rentability in forest management are constantly changing and the original basis may be totally overthrown within half a rotation. Pressler's system of management called for spruce as the most profitable species and pure spruce stands were started generally even on hardwood sites. In the course of time all kinds of destructive influences were encouraged, aside from the damage by fumes which accompanied industrial development. The pure spruce stands rebelled against applied mathematics. Soil deterioration set in, accompanied by a very appreciable decrease in growth and increment. Insects and disease ran rampant through the stands. The net result was that in 1922 the finance ministry increased the rotation to 120 years for pine and 90 years for spruce and established new principles and objects of management. Among these may be mentioned that under the present management, growing stock and rotation are to be kept high rather than too low, so that a surplus may be on hand to provide against any natural or economic emergencies. In 1913, the rotation for pine on the Prussian state forests was 110 years, for spruce 90-94 years. Prussia's management was based on the forest rental rather than on the soil rental theory. However, by virtue of Trebeljahr's E. B. R. A. (supplemental working plan instructions) of 1919, the rotation for pine, and to some extent for spruce has been changed to 100 years; this being the mean of a 120, 100 and a 60-year basis in the proportion of 2:3:1 which is to be applied in the same districts and for the same species. It has since been shown that the actual rotation figures out 94.7 years. In spite of Saxony's bitter experience, Prussia is starting out on a course which is doomed to failure. It is hard to see why the rotation should be

reduced below the old one which itself was as low as the present-day demands of a soil rental management permit. Trebeljahr is guilty even of failing to establish his reductions on a mathematical basis. One ray of encouragement in Prussia's present course is that experiments are being made with the new form of "continuous" forest (Dauerwald) which will tend to mitigate the destructive influences of clear cutting.

J. ROESER

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Compiled by Helen E. Stockbridge, Librarian, U. S. Forest Service.

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NOTES

Who Will Lead Forest Research?

Jurisprudence is a science but what lawyer would class himself among scientists? Medicine is a science but what physician would dub himself a scientist? Agriculture is a science but what farmer styles himself a scientist?

Yet we, in forestry—scilicet in *American* forestry—are making every effort to pass as scientific foresters, with the result, on the one hand, of ridicule, on the other, of lack of jobs for our progeny of foresters.

No forest conservator in the English service, no conservateur in the French, no forstmeister in Germany or Switzerland, no jägmästare in Sweden, and certainly no supervisor of any National Forest has ever tried, to my knowledge of them, to pose as a scientist. And yet, if there are any foresters in this world worthy of the name, where are they unless we find them in the position of conservator, forstmeister, jägmästare and supervisor, and in actual complete charge of all operations within certain lands designated as forests?

Who will lead forest research? Most assuredly, the conservators, forstmeisters and jägmästare will *not* lead forest research; just as little as medical research is led by physicians or as agricultural research is led by farmers. Foresters as professional men may try and steer forest research by advice, by queries, by praemia and by financial support; more than that, a few young men may, *after passing their exams in forestry,* engage for a lifetime in scientific research and, doing that, may abandon any chance or hope of becoming conservators, forstmeisters, jägmästare or supervisors. There is bio-chemistry, physiology, nematology, bacteriology, ecology, colloidology, photosynthesis, enzymes, catalysts, parasitology, entomology, ornithology, pathology, arachniology, rotatoriology—and all the multigenerous scientific topics abstracted in "Biological Abstracts"—all for the research scientist to choose from. All? No. One!

Only one; nay—only part of one. *"Meden agan."* (Nothing too much).

A wonderful, an enticing variety of life-works: But—no chance for a present or future conservator, forstmeister, jägmästare and supervisor to add much, if anything, by his own activity, to that store of

scientific knowledge in all of these most important lines of science which his training at this or that school may have inculcated upon him.

Forestry is a business; and *he* is the best forester who can take charge of that business, somewhere, and make it pay. To that end, a knowledge of affairs and a knowledge of man is more essential than is research work in bio-chemistry and plant physiology and in the rest.

Do not misunderstand me. Among all men known to me, foresters the world over are *The Best Educated Men.* Talk to a conservator about the economics of his beat, and he will be a revelation to you; talk to a jägmästare about aesthetics in his revir, and he will open your eyes; talk to a forstmeister in Hinter-Pommern about history, and he will leave you gasping. A real forester has and must have—because forestry is a business—an all-comprising general education; bank reports are of as much interest to him as are X-rays; paleontology appeals as much to him as does a decision of the Interstate Commerce Commission. But when it comes to scientific research—I have yet to meet a forester in charge of a forest who claims to be engaged in it, or who claims to be a scientist.

No! Forest research is one thing, and forestry is another thing. *Non possumus omnia omnes.*

C. A. Schenck.

A Noteworthy Event

Unheralded and unsung, an event in Federal Forest activity took place last spring that in the future will have a great bearing on the National Forest work east of the Mississippi.

The National Forest Reservation Commission approved two purchase units in the Lake States under Section VI of the Clarke-McNary Act for the purpose of timber production alone. This represented the first action by the Commission under Section VI of the Act and was the result of a good deal of effort on the part of the men who were in contact with the Commission. It is greatly to be hoped in behalf of furtherance of forest practice in the region that additional areas may be approved. That these National Forest units were sadly in need of consolidation and that the step taken by the Commission is of some import may be gleaned from the figures on acreages.

UNIT	Government Owned	Private and State Inside Forest	Additional Area Approved	Total Additional Acreage
Michigan National Forest	84,860	49,749	482,361	532,110
Superior National Forest	900,161	468,377	353,060	821,437

Now that the work of establishing the precedent and laying out the purchase areas is completed, the policy upon which the units were delineated and the purchase program itself have been and will no doubt be subject to some criticism and suggestion, particularly that in Michigan. The preachments of the idealist may impeach a program built upon the sand of northern Michigan. However, the idealist rarely is controlled by the harsh tether of expediency and existing conditions. As a matter of fact, within the Michigan National Forest on those sands, there are some 12,000 acres of flourishing plantations. Row upon row of sturdy Norway pine that are a delight to the heart of any forester. The purchase unit is already under the National Forest system of protection. The limited acreage and interspersed private holdings put per acre protection and administration costs clear out of reason on this area. Every acre purchased will bring this important cost item down.

Some say that these sands won't produce good pine, some say they will. Some say there never was good pine there, some say there was. At any rate, we know we have some very satisfactory plantations that have passed the critical period and are growing rapidly.

There is a vast acreage in Michigan and Minnesota upon which private forestry will never be practiced. It will always be a governmental function to handle this land. Upon the better grades, it seems reasonable that private enterprise will take the lead. Even now there is an encouraging sign here and there even with adverse fire conditions and unsatisfactory taxation, but at best there awaits an enormous task for public foresters in these states that should be under way. As far as Federal work is concerned, the first and most difficult step has been taken, the establishment of a purchase policy for timber production. Certainly it would not be sound judgment to continue with the Michigan and Superior units that we already have carrying perpetually an excessive burden of protection costs and the extreme hazard of large acreages if intermixed with private holdings. Additional units in Michigan no doubt may be laid out where results are more certain and more rapid growth may be secured. However, there should be no trespassing by public agencies on a potential field of private forestry.

E. W. Tinker.

Fires and Game

"More game and other useful wild life is destroyed by needless grass fires turned loose in the spring than by illegal hunters and poachers during the entire year."

This statement has been issued by the Madison Chapter of the Izaak Walton League, which is trying to induce land owners in Dane County to avoid unnecessary burning over of marshlands, meadows, swamps and woodlots.

The League claims that the reason why there are any prairie chickens left in Dane County is because the large grassy swamps interspersed here and there among farm lands provide cover and nesting sites for the birds during the spring season when ploughed fields and pastures are necessarily bare. If, during this critical period, the grassy swamps are needlessly burned off, the birds have no place to nest and no hiding places in which to escape from hawks and other natural enemies. Accordingly they tend to perish or leave the country.

"It is an absurdity," Mr. Aberg says, "for well-meaning but uninformed citizens to think that they are conserving bird life by erecting artificial bird houses when they at the same time insist on burning up the natural nesting sites of beautiful songsters like the meadowlark and the field sparrow."

Burning of swamps and marshes also destroys great numbers of duck nests in places where these birds breed, the League asserts. Even wild geese have been found roasted to death where fires run during the nesting season. The U. S. Biological Survey rates grass fires as one of the most destructive factors threatening the supply of American waterfowl.

Grass fires are like forest fires, Mr. Aberg says, in that they usually escape through carelessness and are tolerated by the uninformed in the belief that they "do no harm." Scientific studies show conclusively, however, that like forest fires they gradually decrease the fertility of the soil by burning up the humus. They also usually reduce the vitality of the desirable grasses and thus encourage the spread of undesirable grasses and weeds. Both the land owner and the public loses when grass fires are allowed to indiscriminately run over the country.

These grassy swamps are not usually deliberately burned by the owner, the League claims. They are often burned accidentally by the escape of fire from legitimate cleaning up of neighboring fields. Even when the owner has some legitimate object in burning off grass lands, the League pleads for the retention of at least a few unburned spots in each swamp for the birds to nest in.

"We have no selfish object in pleading that cover be left for our remnant of prairie chickens," says Wm. J. B. Aberg, president of the

Madison Chapter of the League. "There is no open season on these birds in the Madison region. We claim, however, that their presence here adds to the attractiveness of Dane County and to the value of its farm lands."

Even vacant lots in Madison and other cities are needlessly injured by burning off the grass in spring, Mr. Aberg says. Meadowlarks and other ground-nesting songbirds which add to the attractiveness of suburban districts are left without nesting sites by the universal practice of burning off dry grass. If the object of burning is to get rid of waste paper and trash, then the remedy should be to enforce the dumping ordinances rather than to burn up the nesting places of the birds.

ALDO LEOPOLD.

Chairman Publicity Committee, Madison Chapter Izaak Walton League.

Collection of Long-Leaf Pine Seed in Texas

Mr. P. H. Garrison, Assistant Forester of the Great Southern Lumber Company, has recently sent me some very interesting data on the collection of long-leaf pine seed in Texas. Thinking this data worthy of publication I secured Mr. Garrison's consent to my arranging it in suitable form for printing in the *Journal.*

He states that in October last he was sent to Texas by his company to collect long-leaf pine seed to be used in direct seeding and in the nurseries at Bogalusa, Louisiana. Mr. Garrison had no previous experience in the collection of forest tree seeds. He kept very careful account of all expenditures incurred in each process of collecting, cleaning and shipping the seed to Bogalusa. The costs include a charge for personal expenses; the cost of all material used and the cost of labor employed. The charge does not include the cost of trucking the cones from the woods to the warehouse or the transportation of the seed from Lufkin, Texas, where collected to Bogaluso, Louisiana. The figures given are therefore the actual cost of collecting the cones and extracting the seed. The seed were extracted in a crude kiln of canvas inside a large frame building. Two wood fires were kept continually burning in this kiln during the entire period of extraction. The extraction was a slow process under the conditions imposed and was made slower due to the excessive amount of rain that the cones were subjected to while being transported to the warehouse. There was practically no seed in Mississippi and Louisiana and the crop in the vicinity of Lufkin, Texas, was only a fair one.

The number of bushels of cones gathered was 1,021 and the time of collection extended over a period of 30 days. The cost per bushel was a little over 45 cents. The number of pounds of unwinnowed seed extracted was 1,019, there being approximately one pound of seed to one bushel of cones. The time required to extract this seed was 54 days, the kiln having a capacity of 124 bushels. The cost of extraction per pound was a little over 95 cents. The total cost of collection was $469.97, made up as follows:

Labor $206.35	Personal $108.57
Material 30.05	Supervision.. 125.00

The different items entering into the cost of 45 cents per bushel for collecting were:

Labor ......$ .2021	Personal ....$ .1063
Material .... .0294	Supervision.. .1125

The total cost of $983.90 for extraction was made up as follows:

Labor $256.50	Personal $216.95
Material 162.95	Supervision.. 250.00
Storage $97.50	

The cost per pound for extraction was $ .9535, made up as follows:

Labor ......$ .2517	Personal ....$ .2109
Material .... .1500	Supervision.. .2453
Storage .....$ .0956	

Summarizing the above the total cost per pound of unwinnowed seed was made up as follows:

Labor ......$ .4538	Personal ....$ .3172
Material .... .1794	Supervision.. .3578
Storage .....$ .0956	

The total cost per pound......................$1.4038

J. W. Toumey.

SOCIETY AFFAIRS

Our Society—What?

> "The Society of American Foresters was founded to enable Foresters to do collectively what as individuals they could do poorly or not at all."—Samuel T. Dana.

In these few words President Dana summed up the whole cause and reason for the Society's being.

It has long been my humble opinion and cause for regret that we, as a Society, have failed signally to live up to the possibilities of that statement. It seemed that the Society has been ineffective, almost inconsequential and has lived in a spineless sort of fashion, and in common with foresters generally, went through life with an innocent know-nothing air. True it was, that forestry in the United States was a new thing and maybe we did not know, but the public and everybody else knew a whole lot less. When they turned to us for knowledge and authority, we were not there. Much of this has been overcome, but we are still a long way from the position we ought to hold in forestry affairs. There is still very much to be desired; much, very much to be done and it is with great satisfaction that I welcomed this move to put a "kick" into our Society.

This kick had its genesis in the Executive Council's adoption of a new progressive—shall we say "aggressive"—policy. I think that policy should be aggressive. We have wasted many years; a critical phase of forestry is with us and aggressiveness is necessary to put the Society in its rightful relation to the public welfare. How aggressive—or even progressive that becomes lies with each one of us members individually.

I confess, that the policy of *laissez faire,* let us call it—I think it was even worse—adopted before my advent not only discouraged, even disgusted me, from attempting any constructive efforts. For I was only a field man, out of touch with those seductive things that shape policies around political centers, and it was not for me to say what the Society should do. Yet down in my heart I cursed the policy that kept us from soiling our figurative fingers with the soil of practical forestry and leadership in forest legislation.

Forest policies! Ye gods! The people did not know; the statesmen did not know, there was no other scientific body that knew the first principles of forestry let alone policies. We foresters, scientifically trained foresters, were supposed to know; yet we went about professing

we didn't know! "We were not sure"—"forestry was so new"—"we might err in advising certain practices"; "we had better not rather than have time prove us wrong in after years." Then again, "We were the 'pure' scientists and not concerned with the practical 'applied' forestry." It would be beneath our dignity to point the way to the practical application of forestry principles; in other words, serve the public need with "applied" science.

We are facing a period of increased need and an increased opportunity. What are we going to do about it? Are we going to take our rightful place as leaders in forestry; or, are we going to sit back and let some non-technical or "foreign" technical body take the lead? By our vote we are overwhelmingly for it, yet by our refusal to support the Society's enlarging activity we betray ourselves.

After all these years we have spent in quibbling, mincing and side-stepping issues, it seems that the one thing this nation needs most and now is, "applied" forestry, and if we are going to serve it well and faithfully and with credit to the Society, we should strive for the practical application of the principles and data already at hand—and there is a mass of it—as well what we will still produce. In this way, and this way only, can we attain to the leadership and respect of the public and among ourselves that as a profession we should rate. In this way only can we retain that ancient and honorable ideal that was the moral force and backing of the early foresters.

Our Executive Council has made a start—a good start in the right direction and has shown the way. But it is only a start, and if not backed up by each individual member singly and collectively, that is all it ever will be. This means real individual effort of every member in either time or money or both. In some cases it may even mean some sacrifice of our own personal convenience or even viewpoint. What we need is a little more of the old time spirit of "service to the nation first."

To be wholly successful in assuming leadership there are a number of concurrent desiderata to be taken into account, of which the larger finances is perhaps the most obvious, yet perhaps not the most important. Considering the Society's larger usefulness and accomplishment always associates itself in my mind with that of the A. A. E. First, in membership; in comparison we are only a small body, but worse yet, we have held a policy that excludes from membership a large body of men—probably more in number than our total membership, men who are to all intents and purposes as truly foresters as any within our

ranks. Men who have given their lives in service to the national forestry cause, who are more intimately concerned and just as loyal as any who ever came out of a college door. Men who if they were associated with us would work just as hard and as earnestly for the good of the Society, and that without the petty sniveling selfishness voiced by one of the western Sections. I am convinced that unless we do as does the A. A. E. and make it possible and desirable to include in our membership every man of the calling who is worthy and has proven by his years of service or devotion to the cause, that our influence and leadership will continue to be as it has been in the past, a rather indefinite quantity. I would favor bringing them in as members, raise the technical men to senior member and make possible for members to enter the higher ranks for exceptional, meritorious and outstanding service.

If we can do this we should more than double our membership, which in itself would go a long way toward solving our finances. Yet our dues are too low. On the other hand under the conditions that have held, the proposed increases were perhaps too much for what we had been getting in return. With increased membership, aggressive policies and increasing services to members rendered made possible thereby, somewhat increased dues ought to be acceptable to all. Seemingly six, ten and twenty-five dollars for the respective grades ought not be considered either excessive or prohibitive.

The only aggressive policy and program that will put us solid with the public at this time is one that has for its keynote the practical application of forest principles as now known and to be revealed for the establishment, production and utilization of growing forests for the nation and real service to the public. The latter may well include popular education.

By no means should there be any let up in the code of standards nor of the high ideals that have characterized the profession. On the other hand they may well be raised still higher. But the rather false vanity that has at times shown a tendency to become evident may well and with profit be left out. There should be a rather definite and well kept code of ethics, moral and professional, governing the members and increasing in strictness and definiteness for the higher grades. These should be enforced with speed and justice, that there may be a greater feeling of respect and loyalty thereto, and promoting *esprit de corps* and dignified pride in the organization.

It is appreciated that there may be members who hold views at variance with some of these, but let it be said that there is no intention

of raising a contention, this being the ideas of only one member who at present is more or less isolated from his fellow foresters and who is hardly in close touch with current affairs, the whole desire being to promote a larger, more useful Society of American Foresters.

KAN SMITH, *Member.*

Proceedings of the World Forestry Congress

The International Institute of Agriculture announces that the proceedings of the World Forestry Congress at Rome April 29 to May 5, 1926, will be published by it before the end of the present year. The proceedings will include some three hundred reports submitted to the Congress, and will form five octavo volumes of about 3,500 pages. These will be divided as follows:

Volume I: Regulations and program of the Congress, list of members, text of the resolutions and recommendations approved by the Congress, general report, etc.

Volume II: Reports on forestry in its statistical, political, economic, and legal aspects, and on instruction in forestry.

Volume III: Reports on trade and industry in timber and other forest products.

Volume IV: Reports on technical problems relating to forestry and forestry operations.

Volume V: Reports on control of torrent waters, reforestation of mountain areas, plant diseases and other injuries, fish and game, touring, propaganda, and tropical forest resources and forest utilization.

Prices of the complete work are as follows:

Members and Associate Members	175 lire
Advance orders booked before Nov. 30, 1926	250 lire
Subsequent orders	300 lire

Payment will be accepted in American money according to the current rate of exchange, now about 25 lire to the dollar. Orders should be placed with the Publications Office, International Institute of Agriculture, Villa Umberto I, Rome, Italy.

A list of the reports to be included in the proceedings can be obtained either from the Institute or the undersigned.

S. T. DANA, *Chairman,*
Committee on International
Relations in Forestry.

New England Section

The New England Section held its summer meeting in conjunction with the New York Section at Breadloaf, Vt., on the Battell Forest, a 30,000-acre tract which belongs to Middlebury College. Arrangements were in charge of J. J. Fritz, forester for the college, and R. M. Ross, Forest Commissioner of Vermont. There were more than 80 present, including about a dozen wives. This is what comes from arranging summer meetings at attractive places. Visits were made to operations on the Battell Forest, to several wood using industries in the vicinity and to the state nursery at Burlington. An evening musicale and dance was part of the program. What is the forestry profession coming to? The New England Section nominated nine new members and passed the usual grist of resolutions, one of which asks the Council to hold another referendum on the matter of a paid secretary.

H. O. COOK, *Secretary.*

Sections of the Society of American Foresters for 1926

Allegheny

J. A. Ferguson, *Chairman,* State College, Pa.; L. E. Staley, *Vice Chairman,* Department of Forests and Waters, Harrisburg, Pa.; H. R. Condon, *Secretary-Treasurer,* Broad Street Station, Philadelphia, Pa.

California

C. L. Hill, *Chairman,* Forest Service, Ferry Bldg., San Francisco, California.
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